

IDA

INSTITUTE FOR DEFENSE ANALYSES

Review of Navy Requirements for the Fallon Range Training Complex

L. D. Simmons, Project Leader

April 1999

Approved for public release;
distribution unlimited.

IDA Paper P-3470

Log: H 99-000774

19990617 058

This work was conducted under contract DASW01 98 C 0067, Task EK-1-1720, for the United States Department of the Interior, Bureau of Land Management, Nevada State Office. The publication of this IDA document does not indicate endorsement by the Department of Defense, nor should the contents be construed as reflecting the official position of that Agency.

© 1999 Institute for Defense Analyses, 1801 N. Beauregard Street, Alexandria, Virginia 22311-1772 • (703) 845-2000.

This material may be reproduced by or for the U.S. Government pursuant to the copyright license under the clause at DFARS 252.227-7013 (NOV 95).

INSTITUTE FOR DEFENSE ANALYSES

IDA Paper P-3470

**Review of Navy Requirements for the
Fallon Range Training Complex**

L. D. Simmons, Project Leader
E. D. Potter

PREFACE

This study was conducted by the Institute for Defense Analyses (IDA) in response to a request from the Nevada State Office of the Bureau of Land Management (BLM). Ms. Terri Knutson from the Carson City District Office served as the BLM Project Officer for the study. Her assistance in helping us obtain information and in coordinating our interaction with Government and Navy personnel at Fallon Naval Air Station was instrumental to our success and is gratefully acknowledged. Additional assistance was provided by Mr. Brian C. Amme at the BLM Nevada State Office.

The project team is also pleased to acknowledge the insightful and constructive guidance provided by the IDA Review Committee. The committee was chaired by Dr. David L. Randall, Director of IDA's System Evaluation Division, and included the following members: Dr. Gary C. Comfort, Assistant Director of IDA's Operational Evaluation Division; BGen Richard Craft, USAF (Ret.); Dr. Ivan C. Oelrich; Mr. Gerald A. Pike; and Dr. Alfred E. Victor. Mr. Philip L. Major, IDA Vice President – Planning and Evaluation, and Dr. David A. Arthur also provided helpful comments.

The project team also acknowledges the contributions of the many BLM, Navy, and Air Force personnel with whom we interacted during the study. Their candid and thoughtful responses to our numerous inquiries added measurably to our understanding of military aviation training and its potential impact on public land.

(This page is intentionally blank.)

CONTENTS

EXECUTIVE SUMMARY	ES-1
INTRODUCTION	1
REVIEW	3
A. Scope of Aviation Training at Fallon	3
1. Types of Training Conducted	4
2. Extent of Training	5
3. Public Concerns Regarding Training	7
B. Feasibility of Alternative Training Methods	8
1. Importance of Flight Operations	8
2. Key Training Elements	11
3. Importance of Range Instrumentation	13
C. Feasibility of Moving Training to Alternate Bases	14
1. Availability of Navy Installations for Training	14
2. Availability of Air Force Installations for Training	15
3. Availability of Alternative Basing for Fallon Units	17
D. Utility of Existing Emitter Sites	17
1. Characteristics of Existing Radar Emitters	18
2. Limitations of Existing Emitters	29
E. Utility of Proposed Emitter Sites	32
1. Characteristics and Advantages of Proposed Emitters	32
2. Locations for Proposed Emitters	35
3. Employment of Proposed Emitters	35
F. Alternative Emitter Locations	37
G. Proposed Modifications to Fallon Airspace and Target Complex	38
1. Airspace Modifications	39
2. Training Land Modifications	39
3. Target Complex Modifications	40

H. Proposed Modifications to Range Instrumentation and Communication	41
1. Range Instrumentation	41
2. Range Communications	42
I. Use of Chaff, Flares and Pyrotechnics	43
1. Chaff and Flares	43
2. Smokey SAMs.....	44
3. Other Pyrotechnic Devices	44

Appendixes

- A. Glossary
- B. References
- C. List of Figures and Tables
- D. Distribution List

EXECUTIVE SUMMARY

The Navy has proposed expanding its aviation training facilities near Fallon, Nevada, by withdrawing additional public land and installing actual and simulated threat radar systems in the eastern portion of the Fallon range. The Nevada State Office of the Bureau of Land Management asked IDA to review the Navy's *Requirements Document for the Fallon Range Training Complex* and provide information to assist in developing alternatives for analysis in the required Environmental Impact Statement. The principal findings and recommendations from that review are presented here.

Effective aviation training requires substantial airspace and sufficient land to accommodate simulated threats and targets. Navy aircrews must be prepared to operate on the modern battlefield with its wide variety of targets and often complex air defenses. In many instances targets and threats will be encountered unexpectedly. Flight operations are essential to prepare aircrews to function effectively in this environment. Simulators and other ground-based training cannot replicate the stresses imposed by modern combat. Typical Navy flight operations involve several types of aircraft, each assigned an essential task so that the mission can be conducted successfully. Realistic training must reflect this characteristic while presenting aircrews with the types of targets and threats expected during wartime. As such, aviation training for a carrier air wing requires a large volume of airspace to accommodate the numbers of aircraft involved and sufficient land space to accommodate simulated targets and threats. Range instrumentation is needed throughout the training complex to record aircraft maneuvers and enable re-creation of training situations for detailed study and review.

Use of other Navy or Air Force ranges to conduct the training now accomplished at Fallon would be impractical. Use of other Navy ranges for carrier air wing training is infeasible owing to the limited air and land space available at other ranges. With few exceptions, a large portion of the airspace at the Navy's other ranges is over water and thus poorly suited for training aircraft to strike targets ashore. Moreover, the Navy's other ranges are all located in more densely populated areas, and must contend with a larger volume of commercial air traffic. Navy use of nearby Air Force ranges (e.g., Nellis, Mountain Home, or the Utah Test and Training Range) is infeasible owing to the Navy's large sortie requirement and the distances that would need to be flown to reach

these ranges. The large number of sorties associated with carrier air wing training could not be absorbed easily at nearby Air Force ranges, which are also heavily used. Even if space were available at the western Air Force ranges, the travel time between Fallon and even the closest of these facilities would reduce available training time and increase training costs. Moving the training conducted at Fallon to an entirely new location would impose substantial costs and raise environmental concerns at least as severe as those at Fallon.

The existing collection of threat radar systems at Fallon no longer provides a realistic training environment for the spectrum of potential adversaries that could confront naval aviators. The principal shortcoming of the existing threat array is the lack of advanced air defense systems that are now being exported to nations potentially hostile to the United States. In addition, all of the threat radars now used at Fallon are located in Dixie Valley and lie within 25 miles of the B-17 target complex. (The location of the existing threat array is shown in Figure I, as are the proposed locations for new radar sites on both Navy and public land. The figure also shows the airspace boundary, which would remain essentially unchanged.) For aircraft flying typical attack profiles, the surrounding mountains mask the incoming aircraft from ground-based threat radars until the aircraft are almost over the valley. This level of threat coverage is representative of only about 10 percent of the targets in typical conflict scenarios.

The threat array proposed by the Navy will facilitate more realistic training for the spectrum of potential adversaries. The proposed array includes advanced threat systems developed by Russia and China as well as U.S. and European systems that have been exported. The Navy plans to use some of these new systems from fixed and mobile sites in the eastern portion of the Fallon range.¹ These locations will enable Navy instructors to devise more realistic training scenarios. With threats located as far as 75 miles from existing target areas, aircrews would be forced to fly through defended airspace for distances of up to 100 miles – a level of coverage representative of roughly 50 percent of targets in typical conflict scenarios. While successful installation of the proposed threat array will provide an acceptable training capability against threats now in existence, over the longer term, the Navy will need to reassess its training requirements

¹ The fixed sites would occupy roughly 5 acres and would include one or more radars along with maintenance and storage facilities, communications equipment, and an electrical generator. Mobile radar systems would be operated from one-eighth acre turnouts off existing roads. The radar and its supporting communications system and electrical generator would be transported to the site by semi-trailer. Navy plans call for the installation of 2-4 fixed sites and 15-18 mobile sites on public land.

periodically to guard against advances in air defense technology and the continued proliferation of such weapons.

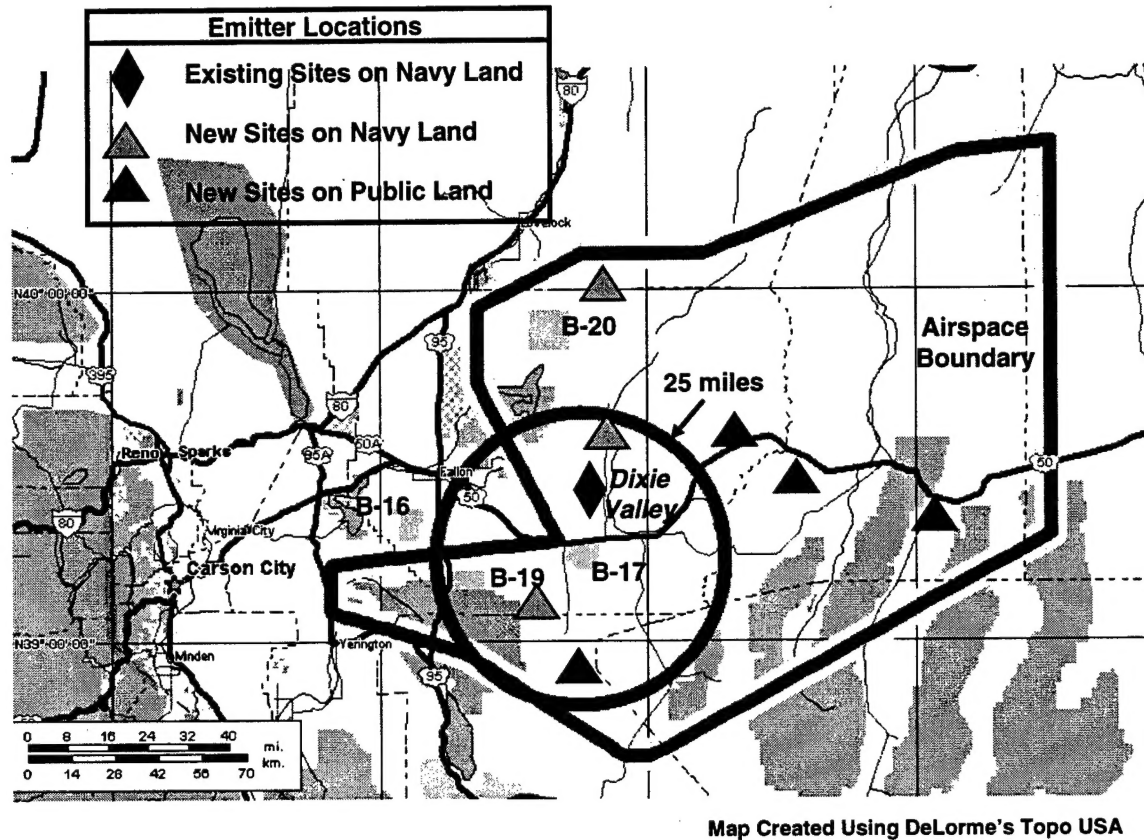


Figure ES-1. Fallon Range Training Complex

Increased reliance on mobile targets and threat systems beyond that now planned by the Navy would further enhance training realism and reduce impacts on public lands. Many of the targets that are attacked by Navy aircraft are mobile, as are many air defense systems. To become proficient at finding these systems and avoiding or attacking them as necessary, Navy aviators must train accordingly. Increased numbers of mobile systems would enable development of a wider variety of training scenarios and prevent aircrews from memorizing threat or target locations. Because mobile systems could be operated from small turnouts off existing roads, their use should reduce the impact on public lands. Whether complete reliance on mobile systems is possible will depend on the Navy's ability to acquire the desired threat systems and to set up the communication systems needed to support their operation.

Proposed changes to the training infrastructure at Fallon will enable more efficient use of the range and will improve the quality of training conducted there. Adjustment of airspace boundaries will enable Navy aviators to employ several new weapon systems and should reduce bothersome noise to area residents. Changes to the target complexes will enable the Navy to spread training activities over a wider portion of the range. In the near-term, changes to the range instrumentation system will enable the Navy to record aircraft maneuvers at all altitudes throughout the range. Over the next several years, other changes to range instrumentation will enable more aircraft to be tracked and should eliminate more than half of the remote tracking stations now installed on the range. Expansion of withdrawn land around the existing target areas is a prudent safety measure and should provide additional protection from explosive hazards and should enable more realistic and higher quality training for Navy and Marine Corps ground forces that operate closely with Navy aircraft.

INTRODUCTION

The Fallon Range Training Complex in Nevada is the Navy's primary tactical combat aviation training facility for overland aircraft operations and the home of the Naval Strike and Air Warfare Center. Fallon is the only Navy training complex that can house, support, and train an entire carrier air wing (which consists of about 70 aircraft and nearly 1,500 personnel). The preponderance of air space used by the Navy (approximately 10,000 square miles) lies over public land managed by the Bureau of Land Management (BLM). Actual Navy holdings include four target areas (designated B-16, B-17, B-19, and B-20) and a portion of Dixie Valley where actual and simulated threat radar systems are based. In total, these areas occupy approximately 100 square miles.²

The Navy has proposed expanding the Fallon Range Training Complex by withdrawing additional public land and installing actual and simulated threat radar systems in the eastern portion of the Fallon range, where none are now located [Ref.1]. According to the Navy plan, 198 square miles of additional land would be withdrawn in the vicinity of the four existing target areas to provide an increased safety buffer for the public and to enable the Navy to conduct integrated air-ground training for Navy SEAL and Special Warfare teams. The plan also calls for the Navy to locate additional threat radar systems in four eastern valleys: Gabbs, Smith Creek, Edwards Creek, and Big Smokey. As prescribed by the National Environmental Policy Act (NEPA), BLM-Nevada must prepare an Environmental Impact Statement (EIS) that assesses the potential environmental impacts of the Navy plan and alternatives.

BLM asked IDA to review the Navy's *Requirements Document for the Fallon Range Training Complex* and provide information that will assist BLM-Nevada in developing alternatives for analysis in the Environmental Impact Statement [Ref. 2 and 3]. This paper reports the results of that review.

² By comparison, the Nellis Air Force Range in southern Nevada includes nearly 12,500 square miles of airspace to support comparably scaled aviation activities. In the case of Nellis, however, over 3- million acres of public land (about 4,700 square miles) have been withdrawn owing to the need to provide security for the test activities undertaken there. [Ref. 4]

The review is structured around the specific questions asked by BLM. Are there feasible alternative training methods or technologies that would enable training to be accomplished with less impact on public land? Are there alternative ranges where the same training could be performed? Can the Navy's long-term training requirements be met utilizing the existing configuration of actual and simulated threat radar systems? Would the Navy proposal for expanding the configuration of threat radar systems meet their long-term training requirements? Are there alternative configurations for the threat sites that could meet Navy requirements while minimizing the impact on public land? To place these questions in context, the review first provides a brief overview of the Navy aviation training conducted at Fallon. Because the Navy's proposed requirements for Fallon also address airspace, target complex, tracking and communications systems, and training land, these topics are also covered in the review, as is Navy use of chaff, flares, and pyrotechnic devices.

REVIEW

A. SCOPE OF AVIATION TRAINING AT FALLON

Aviation training at Fallon is conducted under the auspices of the Naval Strike and Air Warfare Center (NSAWC). NSAWC is charged with providing advanced training for those naval aviators whose missions are to attack enemy targets ashore (strike), suppress enemy air defenses, or engage enemy aircraft in air-to-air combat (air warfare) [Ref. 5-8]. NSAWC also provides training for Navy and Marine Corps elements that operate closely with attack aircraft: forward air controllers, special operations team, and combat search-and-rescue forces. In addition, NSAWC

- develops the tactics and procedures that describe how new weapons or other aircraft systems should be employed, or how new threats should be countered,
- prepares the training and tactics publications that are distributed to all naval aviation units,
- provides oversight for all of the Navy's aviation weapon schools,
- conducts assessments to help set the Navy's priorities regarding strike warfare, air superiority, airborne battle management, combat search-and-rescue, and close air support,
- and supports real world operations, when conditions dictate.

NSAWC includes the Naval Strike Warfare Center, the Strike Fighter Tactics Instructor School (Top Gun), and the Carrier Airborne Early Warning Weapons School (Top Dome). The Strike Warfare Center was originally established at Fallon in 1984 to provide advanced strike training for naval aviators. NSAWC was formed in 1996 when Top Gun and Top Dome were moved to Fallon from Miramar Naval Air Station near San Diego, California, as part of the Base Realignment and Closure (BRAC) decision that closed the Marine Corps Air Station at El Toro, California. The Marine units then moved to Miramar.

1. Types of Training Conducted

Given the charter of the Naval Strike and Air Warfare Center, a variety of aviation training activities are conducted at Fallon. Each of these is described briefly here:

- *Integrated Air Wing Training* – As will be discussed in more detail in the following section, carrier air wing operations involve the simultaneous use of as many as 70 aircraft of several different types in closely coordinated activities. About 1,500 personnel and 70 aircraft are moved to Fallon for the 4-week duration of each course. Fallon is the only Navy aviation-training facility that has sufficient airspace and infrastructure to support the large-scale operations required for this type of training. Four to six carrier air wings train each year at Fallon. In some years, up to two Marine Air Wings also participate in this type of training, although none are scheduled during 1999.
- *Fleet Replacement Squadron (FRS) Training* – This is the initial training in the F/A-18 aircraft and typically lasts 5 to 8 months. Two Navy F/A-18 FRS detachments are permanently based at Fallon.
- *Unit Level Training* – This consists of day-to-day training for deployed squadrons, and involves single aircraft operations as well as formation flights of two and four aircraft. Most Navy F/A-18 squadrons based on the West Coast conduct their unit-level training at Fallon.
- *Typewriting Weapon Schools* – Navy F/A-18, F-14, and EA-6B weapon schools conduct a portion of their training at Fallon. These schools train the aircrews for the indicated types of aircraft in delivering weapons and using the various onboard electronic systems.
- *Carrier Airborne Early Warning Weapons School (Top Dome)* – This school trains the aircrews that man the Navy's E-2C airborne early warning aircraft. The E-2C provides early warning of hostile aircraft and also serves as a command-and-control platform for the aircraft control and battle management activities that are required for large-scale integrated air operations. In addition to training in these activities, E-2C aircrews at Fallon are taught how to identify friendly and enemy aircraft operating over land.
- *Strike Fighter Tactics Instructor School (Top Gun)* – This school trains naval aviators to become instructors in strike fighter tactics so that they can then train the other aviators in their assigned units. Trainees learn advanced tactics to help them find and destroy enemy aircraft while defending themselves and other friendly aircraft from attack by hostile aircraft.

- *Integrated Air-Ground Training* – These activities involve training for Navy and Marine Corps ground personnel who interact with fixed-wing aircraft while conducting close air support and special warfare operations. These personnel learn how to request air support and designate targets for attack by air-delivered weapons. Training activities typically involve several aircraft and a small number of ground personnel. Fallon is the only Navy facility that trains the ground personnel that interact with air operations.
- *Combat Search and Rescue* – This training emphasizes the various activities needed to find and rescue downed aircrews and defend the rescue force from attack. Personnel operating from helicopters usually accomplish the rescue itself. However, if the aircrew has been downed in enemy territory, the helicopter-borne forces will usually need to be protected from enemy interceptor aircraft, surface-to-air threats, and hostile ground forces. Consequently, this training typically involves several different types of aircraft as well as ground forces. Fallon is the Navy's only training facility for the personnel involved in combat search-and-rescue operations.
- *Adversary Squadron* – A Naval Reserve squadron (VFC-13) is based at Fallon to provide simulated threat aircraft for air warfare training. This unit flies F-5 aircraft. Other U.S. adversary squadrons also deploy to Fallon in support of major exercises.

2. Extent of Training

During 1998, approximately 133,600 flight operations³ were conducted on the Fallon Range [Ref. 9, 10]. Figure 1 categorizes these flights according to the type of training involved. Air wing training made up the largest portion of flights, followed closely by F-18 basic training. The next largest components were unit level training and tactics development activities conducted by aviators assigned to the NSAWC. Flights by Top Gun instructors and students accounted for about 5 percent of all flight activity. Joint exercises with other Service aircraft made up only 2.5 percent of all operations. About 75 percent of the air activity at Fallon in 1998 was conducted during daylight hours; the remaining 25 percent of training flights occurred at night. About 75 percent of

³ Aircraft flight operations are usually described in terms of "sorties," with each sortie comprising all of the flight activity that occurs between aircraft takeoff and landing. However, because the Navy wishes to identify the specific activities that occur in various portions of the Fallon airspace, the key segments of each flight are recorded separately. Several of the operations identified here would usually occur on the same sortie. [Ref. 11]

the flights were flown at altitudes above 10,000 feet (relative to mean sea level) and 25 percent took place at lower altitudes.

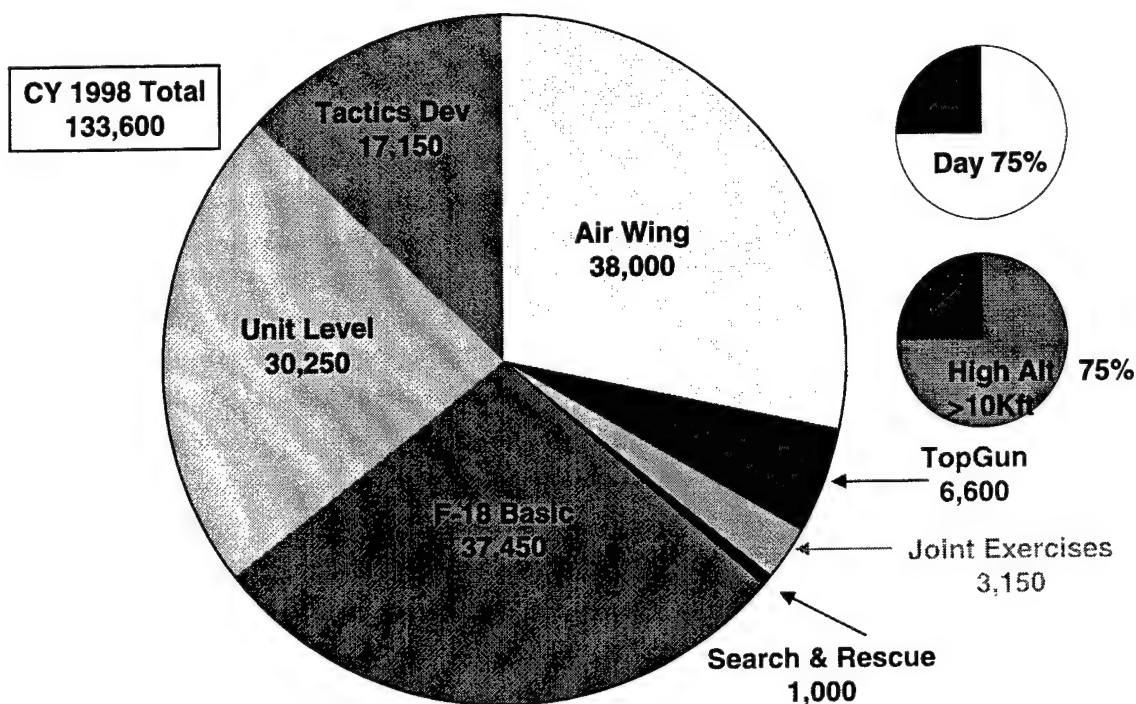


Figure 1. Extent and Types of Flight Operations at Fallon

Navy personnel at Fallon estimated that about 15 to 20 percent of the flights at Fallon are conducted by aircraft operating from outside airbases [Ref. 11]. Most of these are other West Coast Navy units (e.g., aircraft flying from the Navy bases at Lemoore and El Centro, California; Whidbey Island, Washington; or aircraft carriers off the California coast). Other Service aircraft account for only a small fraction of this activity. During 1998, such planes accounted for 3,150 flight operations at Fallon, or about 2 percent of all training activity. Training flights by aircraft that are not based at Fallon must be scheduled through NSAWC Operations. If the range is available, outside units will usually be granted access. However, if Fallon-based aircraft are already scheduled to use the range, requests from outside aircraft may be denied or schedulers may try to accommodate their activities in an unused portion of the range.

According to Navy personnel, the Fallon range is utilized over 85 percent of the time that it is open, typically from 7 a.m. until 11 p.m. each weekday [Ref. 11]. The range is usually closed for air operations from 11 p.m. to 7 a.m. It is estimated that the

range could support only 5 to 10 percent more activity during daytime hours. A more substantial increase in utilization would require that the Navy conduct more flights late at night. Because the facilities are now staffed for two work shifts per day, late night flights would require the addition of a third shift at considerable cost. Factors that limit utilization are ramp space for aircraft, housing for aircrews and maintenance personnel, and the volume of airspace over the range.

3. Public Concerns Regarding Training

Experience has shown that the aviation training activities conducted at Fallon give rise to a variety of public concerns [Ref. 3 and 10]. The most frequent of these are complaints regarding the noise (and occasional damage) caused by low-altitude flights and sonic booms. The presence of military equipment such as radars and communications facilities in otherwise remote areas creates a visual intrusion that is bothersome to some people. Others are intimidated by the military activity conducted on the range, especially when ground forces are involved. Citizens involved in grazing, mining, and outdoor recreation express dismay when they are denied access to what would otherwise be public land. The electromagnetic radiation emitted from ground-based threat radars (whether actual threat radars or simulators) is of concern to some, as is the Navy's use of chaff during training. Other causes for complaint include the potential effects of training activities on native plant and animal life, on cattle, and on historical and Native American artifacts.

The Navy attempts to mitigate these effects through a variety of measures. To reduce noise and the damage from sonic booms, the Navy restricts the minimum altitudes and maximum speeds at which aircraft can fly when near populated areas.⁴ An extensive series of public hearings are used to inform persons denied access to public land of the Navy's justification for the closure or withdrawal. To mitigate the effects of chaff, the Navy is developing a new degradable form that should be in available during the year 2000. Appropriate paint schemes and proper siting can reduce the visual impact of military equipment in remote areas. As for the other concerns, the Navy should consider installing warning signs to alert the public when training activities are scheduled and

⁴ These efforts seem to be paying off; data provided by Navy personnel at Fallon show a marked decrease in the number of complaints associated with sonic booms. During 1998, 42 such complaints were reported, compared to 51 in 1997, 118 in 1996, and 100 in 1995 [Ref. 12].

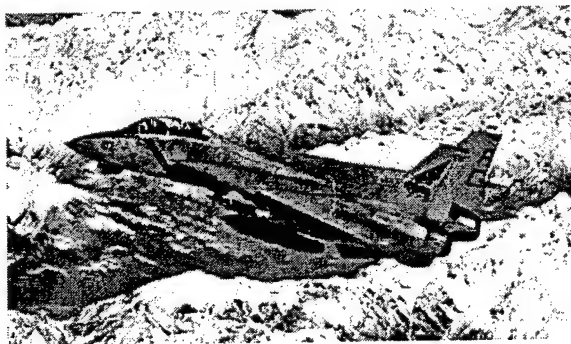
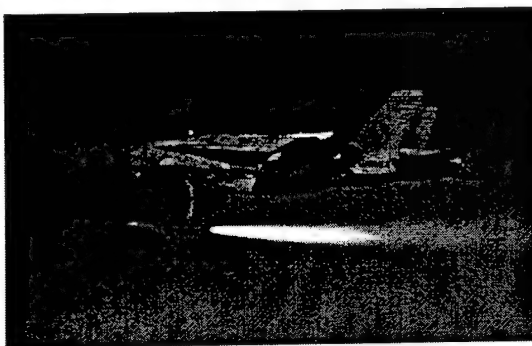
describe the hazard involved, if any. Signs could also be used to alert the public to the potential, albeit slight, hazards from electromagnetic radiation.

B. FEASIBILITY OF ALTERNATIVE TRAINING METHODS

1. Importance of Flight Operations

Carrier air wing operations involve a wide variety of aircraft types and activities, often carefully orchestrated. A typical carrier air wing contains about 70 aircraft of 7 or 8 different types and nearly 1,500 personnel. The aircraft that make up the air wing provide a wide variety of military capabilities. They are able to attack targets at sea and ashore and can help defend the aircraft carrier and its accompanying surface ships from attacks by hostile aircraft, ships, and submarines. The standard makeup for an air wing includes 36 F/A-18 fighter attack aircraft, 14 F-14 fighters, 4 or 5 EA-6B support jammers, 4 E-2C airborne early warning aircraft, 6 S-3 antisubmarine warfare aircraft, 1 or 2 ES-3 electronic support aircraft, and 6 H-60 antisubmarine warfare and search-and-rescue helicopters.

The multipurpose F/A-18 (Figure 2) is used to intercept enemy aircraft, attack ground targets, and suppress ground-based air defenses using high-speed missiles that home on the signals emitted by hostile air defense radars. The F/A-18 comes in single and double crew variants and can carry a wide variety of air-to-air and air-to-surface ordnance. The typical carrier air wing includes three 12-aircraft F/A-18 squadrons.



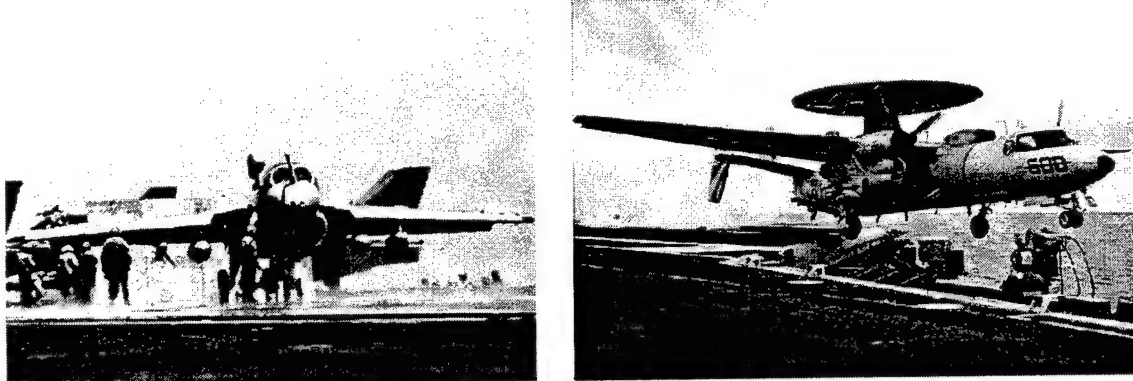
(U.S. Navy Photos)

Figure 2. F/A-18 (left) and F-14 (right)

The F-14 (also shown in Figure 2) was originally designed to be the Navy's principal interceptor aircraft. With the end of the Cold War, its mission has been

expanded to include attacking ground targets. The F-14 has a crew of two and can carry several different types of air-to-air and air-to-surface ordnance. The typical carrier air wing includes one 14-aircraft F-14 squadron.

The EA-6B (Figure 3) is equipped with a variety of sophisticated electronics systems that enable it to locate and jam ground-based air defense radars. Manned by a crew of four, the EA-6B can also carry the high-speed missiles used against enemy air defense radars. The typical carrier air wing includes a detachment of four or five EA-6B jamming aircraft.

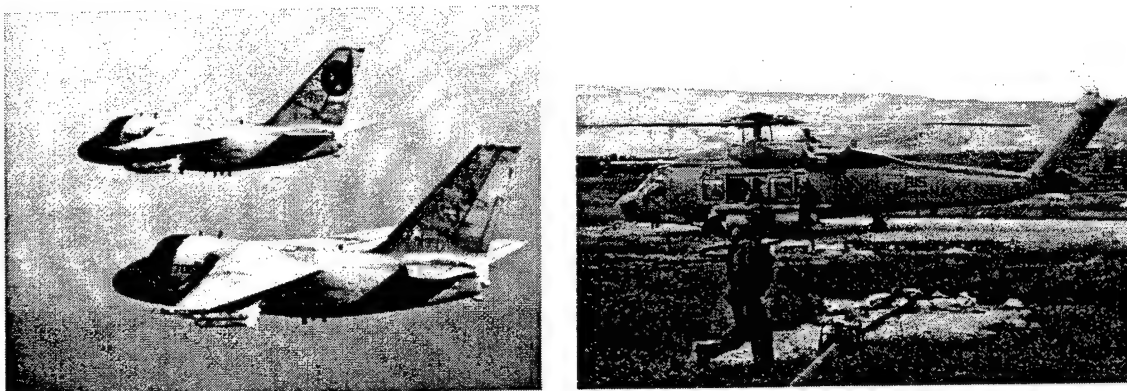


(U.S. Navy Photos)

Figure 3. EA-6B (left) and E-2C (right)

The E-2C (also shown in Figure 3) provides early warning of enemy aircraft and serves as an airborne command and control center. The E-2C is equipped with an air- and surface-search radar mounted in a radome atop the fuselage. Crew for the E-2C includes a pilot and co-pilot along with three radar operators and air control personnel.

The S-3 (Figure 4) is used to search for and attack enemy submarines. Because the S-3 carries a fairly large fuel load, it is often used to refuel other aircraft such as F-18s. The ES-3 variant is outfitted with a sophisticated suite of electronic systems that enables it to collect electronic emissions and identify potential threats. The typical carrier air wing includes a six-aircraft detachment of S-3s, and one or two ES-3s.



(U.S. Navy Photos)

Figure 4. S-3B (left) and HH-60 (right)

Several variants of the H-60 helicopter (also shown in Figure 4) are typically included in the carrier air wing. These include the SH-60 helicopters that are used to search for and attack enemy submarines and the HH-60 models that are used to search for and rescue downed aircrews.

Should conflict occur, Navy aircraft must be prepared to operate on the modern battlefield, where a wide variety of threats and targets may be encountered, sometimes unexpectedly. America's potential adversaries are equipped with a many different types of air defense systems, including surveillance radars, interceptor aircraft, radar-guided missiles, infrared-guided missiles, and anti-aircraft guns. In many countries these systems are linked together into an integrated air defense system in which all activities are coordinated and thereby made both more efficient and more effective. The systems that make up these defenses are manufactured and exported by a variety of countries including the former Soviet Union, other nations such as China, as well as the United States and many of our European allies. Although all of these systems continue to be improved, some are advancing faster than others. In particular, radar-guided missiles grow ever more sophisticated. The newest designs have longer range and higher reach than older systems. The new systems operate at diverse frequencies and employ a variety of guidance schemes. Counter-countermeasure capabilities continue to improve. And, such systems are becoming increasingly mobile, both to enable them to be deployed with tactical units such as armor formations and to help prevent their being located and targeted.

In addition to confronting often formidable air defenses, aircrews must often contend with complex targeting problems. Targets may be located in urban or rural

areas; they may lie in the desert or in a forest; they may be on flat terrain or in the mountains; they may be stationary or mobile. Regardless, aircrews must be able to identify their targets and deliver ordnance precisely, being careful to avoid noncombatants and facilities that the United States does not wish to damage. In many cases, Navy aircraft must operate in close conjunction with ground forces, a mission that requires the availability of trained ground liaison personnel knowledgeable both in the conduct of ground force operations and in the capabilities and employment concepts of aircraft.

When flying these missions, aircrews must accomplish their tasks in the face of severe stresses that are associated with flying in a hostile environment. Because Navy aircraft are almost always flown in formation with other aircraft, aircrews must avoid mid-air collisions. When participating in activities where live ordnance is used, aircrews must avoid the effects of weapons dropped from their own aircraft or by other friendly aircraft. And, if actually engaged in combat, aircrews must avoid enemy air defenses, whether in the air or on the ground. Because even experienced pilots can become disoriented when faced with these external stresses, the potential for impact with the ground becomes another hazard. Although the technical skills associated with flying modern aircraft can be practiced in ground-based simulators, aircrews can experience and grow accustomed to the full range of stresses incurred while flying combat aircraft only while flying. Consequently, *flight operations are essential for realistic and effective training.*

2. Key Training Elements

In general, military training needs are reflected in the slogan "Train as You Fight." Such training requires access to a volume of airspace large enough to accommodate the numbers of aircraft typically used and enough land space to accommodate representative arrays of targets and threats. Because the Navy organizes and deploys its aviation forces as carrier air wings, Navy aviation units need to train as an entire carrier air wing. To achieve adequate realism, training must replicate the pace and confusion of the modern battlefield and tax the capabilities of military personnel. To prepare aircrews to face a wide variety of circumstances, training scenarios must be flexible and easily altered so that they provide a variety of training experiences. Fixed or "canned" solutions need to be avoided. So that the public funds committed to military training are used efficiently, the time and resources devoted to training need to be used as efficiently as possible. Locating the training range close to the aircraft's base reduces

fuel consumption and allows most of the time allocated for each flight to be used for training purposes rather than transiting to and from the range. Along similar lines, the training range needs to include a complete array of targets and threats, and sufficient airspace to enable effective training.

Typical activities undertaken in combat need to be included in training to make it effective. Aircrews must practice air-to-air and air-to-ground maneuvers in concert with other aircraft. They must attack ground targets and protect the attacking force from hostile aircraft and ground-based air defenses. The aircrews that provide battle management, refueling, and jamming support to the attack aircraft must practice their missions as well. Aircrews must become experienced at flying their aircraft at the altitudes and speeds that would be employed in combat, extending from low to high altitudes and from subsonic to supersonic speeds. Aircrews also need to practice delivering ordnance on targets, using the wide variety of weapons now available, and in interacting with ground forces such as those involved in close air support or search and rescue operations. Finally, aircrews must become adept at employing the various types of countermeasures that are used to protect friendly aircraft from an adversary's air defenses. Such actions include dispensing chaff and flares⁵ and employing various electronic warfare and lethal suppression measures.

When conducting these activities, aircrews need to practice the specific tactics that are used to attack targets, to protect friendly aircraft from enemy aircraft and surface-based air defenses, and to conduct such support missions as standoff jamming (EA-6B), airborne early warning (E-2C), threat identification (ES-3), and aerial refueling. Because the tactics used will depend on the numbers and types of threats that Navy aircraft will face, training activities need to be conducted against a variety of air defense systems. Early warning and target acquisition radars, interceptor aircraft, surface-to-air missiles and air defense guns, and the command and control elements of an integrated air defense system should all be represented on the training range. The range should also include a wide variety of simulated targets so that aircrews can become proficient in identifying and attacking them. The distances between targets, between targets and defensive

⁵ Chaff is a countermeasure device intended to deceive air defense radars. Chaff is dispensed in small bundles consisting of about 5 million short aluminum-coated glass fibers. Shortly after being released, the chaff bundle separates so that the fibers can be spread by the wind. The resulting cloud can be tracked by radar and, when combined with appropriate maneuvers, can mask the aircraft's position. Flares, which are made of magnesium, are ignited upon being launched from the aircraft. They emit an intense infrared signal similar to that produced by the aircraft's engines and are used to seduce infrared-guided missiles away from the aircraft.

systems, and between defenses should be representative of the distances that will be encountered in combat.

3. Importance of Range Instrumentation

Scoring weapon impacts and recording aircraft maneuvers for subsequent detailed study and review can enhance the benefits of training. Recording these data requires that appropriate communications and video equipment be installed on the range. The information provided by these systems can be used to reinforce the positive aspects of training and allow aircrews to identify and correct deficiencies. By enabling aircraft to be tracked during their flights, instrumentation also provides a means to enforce airspace restrictions such as those related to supersonic flights. Currently, the Fallon range is outfitted with the Tactical Aircrew Combat Training System (TACTS). Each aircraft being tracked is fitted with a pod that emits a signal that can be detected by ground-based receivers. The aircraft's position in space can then be determined by triangulating the data from three sites that receive the signal. At present 2 master sites and 30 remote sites have been installed. These sites provide adequate coverage over all but the eastern portion of the range, where aircraft flying at altitudes below 10,000 feet above sea level cannot be tracked. To remedy this shortcoming, the Navy plans to install four additional remote sites in the eastern range.

The Navy is developing a new instrumentation system designated the Joint Tactical Combat Training System (JTCTS) that will rely on the Global Positioning System (GPS) to determine aircraft position [Ref. 13]. Each JTCTS-equipped aircraft will broadcast its GPS location to a ground-based receiver, which will then forward the information to a central processing facility. Because the aircraft will need to establish line-of-sight to only a single ground-based communications site, rather than the three sites required by the current TACTS, fewer communication sites will be needed. Once the new system is installed, Navy personnel estimate that they will be able to eliminate about 60 percent of the TACTS receivers now being used. In addition to this benefit, JTCTS will enable simultaneous tracking of up to 100 aircraft, compared to the 36 that can be accommodated using TACTS. Installation of this system is expected to begin in 2001, and the Navy plans to place the JTCTS nodes at existing TACTS sites.) The capabilities inherent in the new JTCTS system may eventually enable some threats to be simulated electronically rather than having to be located on the range. However, such a capability is certainly some years away.

C. FEASIBILITY OF MOVING TRAINING TO ALTERNATE BASES

The arguments above make evident the value of flight operations for training military aircrews and the need for sufficient air and land space to support that training. Although the Fallon range clearly provides that space, might not other Navy or Air Force aviation training ranges be used instead? Or, might a new range be constructed to satisfy the Navy's needs? This section explores those questions.

1. Availability of Navy Installations for Training

Use of other Navy ranges for the training activities conducted at Fallon would be impractical given the limited air and land space available at those ranges. As discussed previously, Fallon provides a large over-ground airspace to train Navy aviators whose assigned tasks require them to fly over land. Because Navy aircraft are based on ships, they must also conduct training over the ocean. With few exceptions the Navy's other ranges provide airspace appropriate for such training (see Figure 5).⁶ In addition to providing large over-land airspace, Fallon is the only Navy range that has the infrastructure capable of supporting carrier air wing training [Ref. 11, 14]. Over the last decade, the Navy has invested approximately \$1 billion in office space, maintenance facilities, and military housing to support training activities at Fallon [Ref. 11].

Fallon also provides other advantages. Among the most important of these is the presence of the NSAWC, which places the Navy's centers of excellence in strike warfare, air warfare, and airborne early warning within easy access of the aviation units that train at Fallon. Aircrews also benefit from the ability to drop live ordnance and conduct supersonic flights, from access to actual and simulated threat emitter systems, and from the availability of TACTS instrumentation that can track the aircraft and record their positions. Fallon's being located within flying distance of West Coast Navy bases (e.g., Lemoore, El Centro, and Whidbey Island) is yet another benefit. The Fallon area also provides consistently good weather. Unlike areas on the East Coast and some on the West Coast, heavy cloud cover, precipitation, or fog seldom trouble central Nevada. Finally, most of the Navy's other aviation training ranges are located in areas of the United States that are much more densely populated than is the area east of Fallon.

⁶ The Navy's only other aviation training base with substantial over-land airspace is Lemoore Naval Air Station located near Visalia, California. Lemoore lacks the airspace and infrastructure needed to support carrier air wing training. In fact, the F-18 squadrons based there conduct much of their ground attack training at Fallon. The ranges at Yuma, Arizona, and Cherry Point, North Carolina, are used primarily by Marine Corps squadrons. Neither is large enough to support carrier air wing operations.

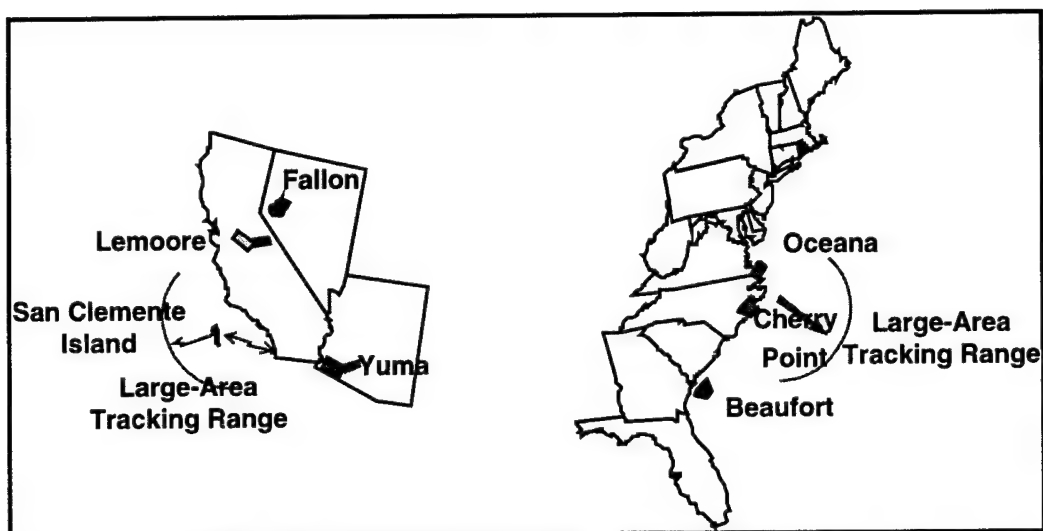


Figure 5. Locations of Other Navy Training Ranges

2. Availability of Air Force Installations for Training

Navy use of nearby Air Force ranges also appears impractical owing to the Navy's large sortie requirement and the distances that would need to be flown to reach the Air Force ranges. Several large Air Force aviation training and testing ranges are located within Nevada and adjoining states (see Figure 6). These include Nellis Air Force Base in Nevada, Mountain Home Air Force Base in Idaho, the Utah Test and Training Range in Utah, and the Barry Goldwater Air Force Range in Arizona. With the exception of the latter installation, these facilities are within unfueled flying range for Navy aircraft based at Fallon. However, the large number of sorties associated with carrier air wing training could not be absorbed easily at the Air Force ranges, which also tend to be fairly heavily used (see Table 1). Even if sufficient space were available at these ranges, the travel time between Fallon and even the closest of the Air Force facilities would reduce available training time and increase training costs. Instead of flying 30 miles to the range at Fallon, Navy aircraft would have to fly at least 200 miles to reach Nellis. Once training activities were completed, more time would be consumed during the return flight.⁷ Moving the Navy's Fallon training in its entirety to any of these ranges would be impractical owing to the significant infrastructure required to support

⁷ A typical sortie lasts about 2.5 hours (150 minutes). Aircraft based at Fallon are within 5-minutes flying time of the range and can spend nearly all their time training. Flying 200 miles to and from Nellis would consume nearly an hour's time, leaving only 90 minutes of each sortie for training.

these activities. None of the associated airbases have sufficient facilities to accommodate a carrier air wing in addition to the Air Force units already located there. Building the needed facilities would impose costs comparable to those already incurred at Fallon.

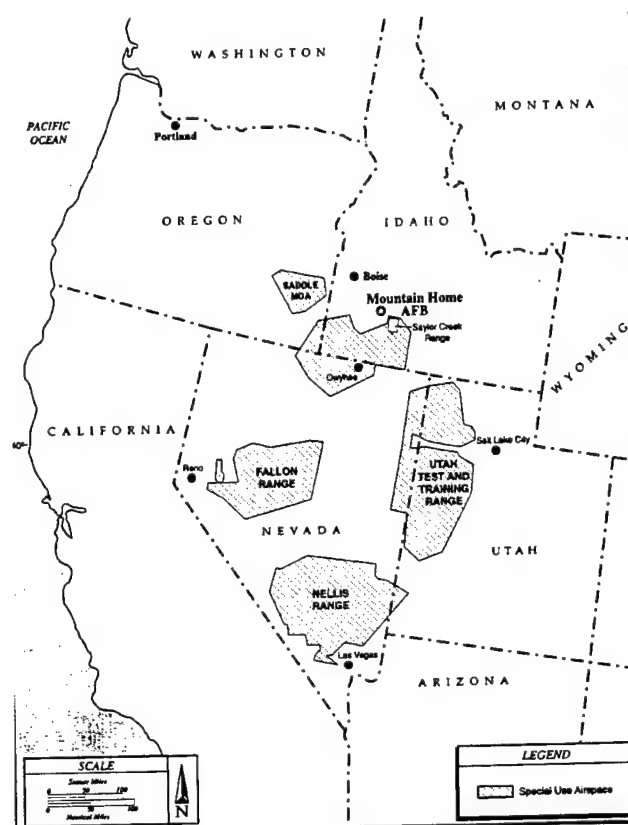


Figure 6. Air Force Ranges Located Within Unrefueled Flying Range of Fallon (Source: Ref. 15)

**Table 1. Flight Distance and Utilization for
Air Force Bases^a**

Range	Distance from FNAS (nmi)	Annual Sorties	Utilization	Potential Additional Sorties^b
Fallon ^c	30	33,000	85%	5,800
Nellis	200	65,000	75%	21,700
Mountain Home	240	8,000	50%	8,000
Utah TTR	230	16,000	40%	24,000

^a Based on information provided in Ref. 15-18.

^b Calculated assuming no expansion in infrastructure (e.g., ramps, runways) or staffing. From these data it is clear that none of the Air Force ranges have the capacity to accommodate the training conducted at Fallon in addition to their current activities.

^c Fallon data are included for reference.

3. Availability of Alternate Basing for Fallon Units

Relocating the Navy aviation training conducted at Fallon to a new range would impose significant economic and environmental costs. Few other locations could provide all of the positive features that the Fallon area provides. As has been shown, large amounts of land and airspace would be required to accommodate the types of training undertaken at Fallon. In addition, substantial support and housing facilities would need to be constructed. Moreover, building a new range would require the Navy to withdraw or purchase substantially more land than is now withdrawn or is proposed to be withdrawn at Fallon. New Federal Aviation Administration (FAA) restrictions require that the airspace user own or control the land under the airspace if operations involve flights at altitudes less than 1,200 feet above ground level [Ref. 19]. The Navy estimates that such flights occur within about 2,000 square miles of Fallon airspace. Because existing ranges have been "grandfathered," these restrictions do not apply to the on-going training activities at Fallon. In addition to these impediments, it is likely that any new location would confront environmental issues at least as severe as those at Fallon.

D. UTILITY OF EXISTING EMITTER SITES

The current collection of threat radar systems found at Fallon represents an integrated air defense system (IADS) typical of the many such systems that exist around the world today. The array includes a variety of different air defense radars as well as a

communications jammer and several infrared-guided missile systems. With the exception of the IR-guided missiles, all of these systems emit electromagnetic radiation and thus are referred to as emitters. In the sections that follow, we first discuss the general characteristics of these systems and then assess their utility for training Navy aviators to operate effectively on the modern battlefield.

1. Characteristics of Existing Radar Emitters

The radar systems and simulators employed at Fallon are typical of surface-to-air threats developed in the 1960s and 1970s and deployed by many nations during the 1980s (see Table 2). Because these systems were designed with specific purposes in mind, they differ in the frequency at which they operate, in their range, in their size and mobility, and in their resistance to electronic countermeasures. Given these differences, one radar system cannot be freely substituted for another.

Table 2. Current Threat Systems or Simulators Used at Fallon

Name	Country of Origin	Guidance Mode	Fixed or Mobile	Range
SA-5	Russia	Radar	Fixed	Long
SA-2	Russia	Radar	Fixed	Moderate
SA-3	Russia	Radar	Fixed	Short
SA-6	Russia	Radar	Mobile	Short
SA-8	Russia	Radar	Mobile	Short
Rapier	Great Britain	Radar	Mobile	Short
SA-16/18	Russia	Infrared	Man-Portable	Very Short

Figure 7 identifies the general types of emitters currently in use at Fallon. The four general categories displayed in the figure are (1) early warning and acquisition radars that are used to detect aircraft at long range; (2) height-finding radars that are used to determine the altitudes of incoming aircraft, usually in conjunction with older early warning and acquisition radars that are able only to determine the range and azimuth to the target; (3) surface-to-air missile target-tracking radars that provide precise target tracking information so that a missile can be launched against the targeted aircraft; and

(4) anti-aircraft artillery (AAA) target-tracking radars that serve the same purpose for anti-aircraft guns.

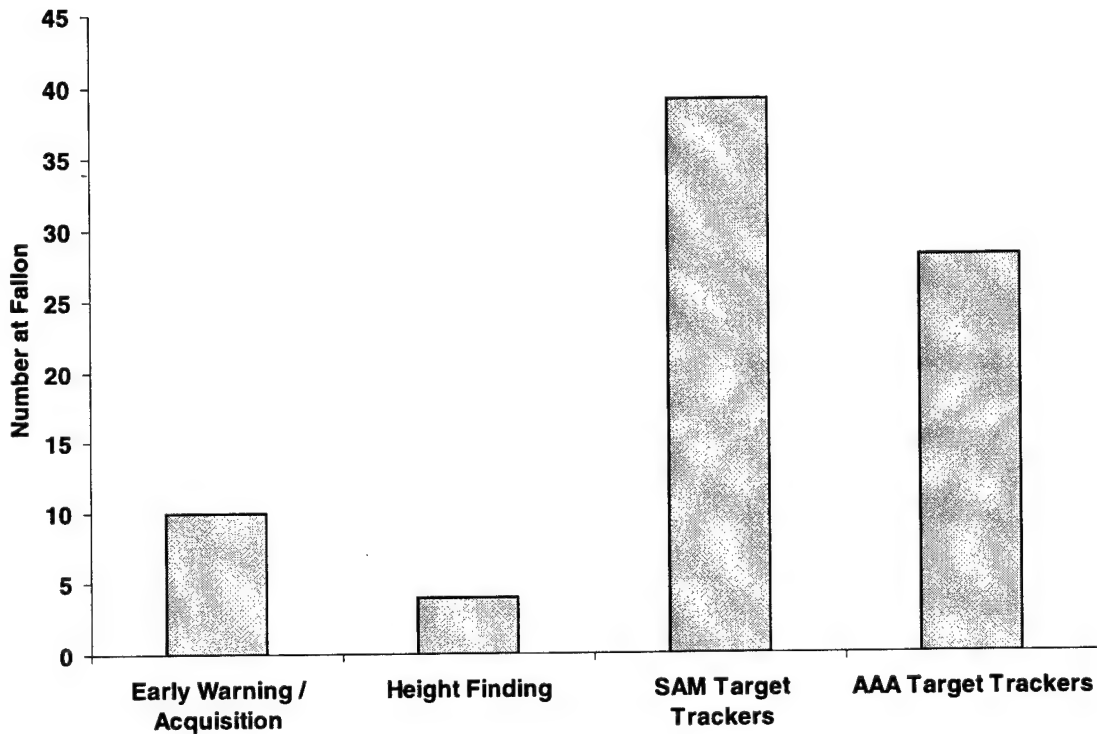


Figure 7. Radar Types Found in the Current Configuration at Fallon Training Range⁸

a. Early Warning and Acquisition Radars

Early warning and acquisition radars serve to alert the other components of the air defense system that potentially hostile aircraft have entered the defender's airspace. Typical characteristics of these radars include the following:

- Longest range--usually greater than 150 nautical miles
- Lowest frequency--often below 6 gigahertz (6×10^9 hertz)

⁸ The current threat array at Fallon comprises some 44 actual and simulated threat radar systems located at 37 different sites. However, because the simulators can act as several different types of radars, the number of potential radars totals to 81. Although only one mode can be simulated at any one time, each of these separate modes has been included in the numbers shown here.

- Largest antennas--tens of meters across
- Lowest mobility owing to their large size
- In operation at all times.

Because the low frequency radiation emitted by early warning radars is less severely attenuated by the water-vapor and oxygen molecules in the atmosphere than is the higher frequency radiation emitted by tracking radars, early warning radar systems can detect incoming aircraft at very long range. However, the use of low frequency implies that early warning radars have very large antennas (the area of the antenna needs to be proportional to the inverse of the square of the frequency). And as a consequence, considerable time is needed to disassemble these systems so that they can be moved. A comparable interval (on the order of several hours) is then needed to reassemble the radar and restore it to operation. Finally, since these systems are designed to alert other defensive systems of an incoming aircraft, they must emit radiation continually. Figure 8 shows a Russian-built Flat Face radar, one of several early warning and acquisition radars found at Fallon.

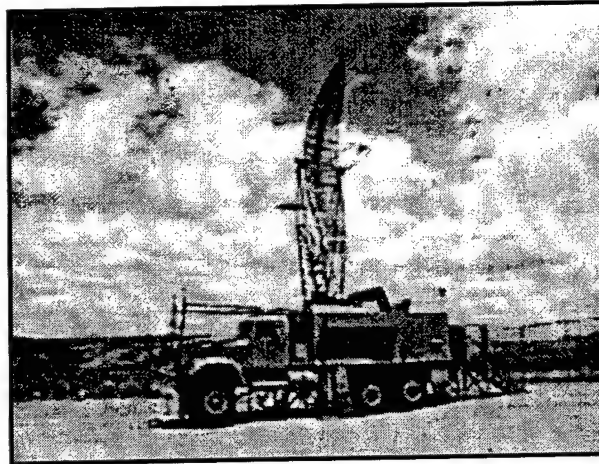


(U.S. Navy Photo)

**Figure 8. Example Early Warning Radar:
Russian Flat Face**

b. Height Finding Radars

As indicated previously, height finding radars complement early warning radars by providing the target's altitude and thereby enabling its location in three dimensions (range, azimuth, and altitude). Older early warning radars usually have radar beams that are relatively narrow in azimuth but broad in elevation. Consequently, these radars are only able to indicate the particular direction from which an aircraft is approaching, but not its altitude. The height finding radar is essentially an early warning radar with the antenna turned 90 degrees to provide a beam that is narrow in elevation and broad in azimuth. Unlike the antenna on an early warning radar that rotates to find aircraft coming from any direction, the antenna on the height finding radar "nods" up and down to locate the aircraft in elevation. The characteristics for these types of radars are similar to those cited for early warning radars, except there is no need to have the height finding radar emit energy until the early warning radar detects an aircraft. Figure 9 shows a Russian-built Thin Skin height-finding radar located at Fallon.



(U.S. Navy Photo)

**Figure 9. Example Height Finding Radar:
Russian Thin Skin**

c. Target Tracking Radars

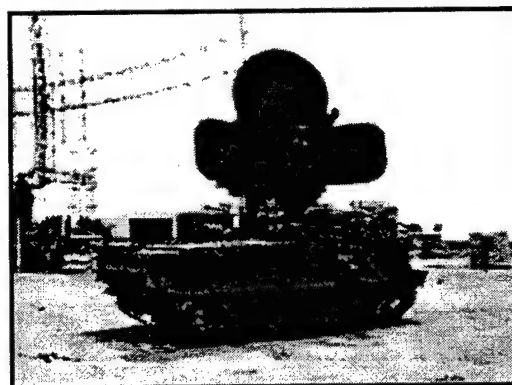
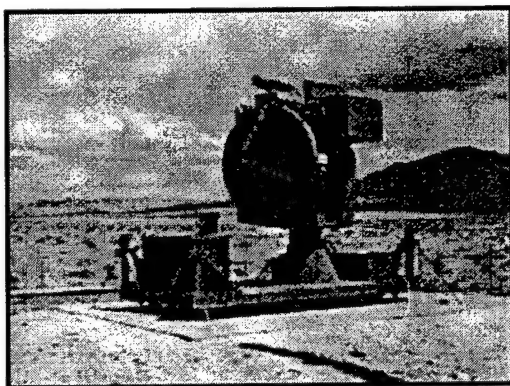
Target tracking radars are designed to enable the operator to determine the aircraft's position accurately enough that weapons can be launched against it. By recording those positions over time, the radar tracks the aircraft and predicts its future position. This information is used to determine an appropriate trajectory for a surface-to-air missile or to establish an aim point for an air defense gun system. Target tracking radars are characterized by the following:

- Narrow "pencil" beams
- Typically operate in the 8–12 gigahertz (8×10^9 to 12×10^9 hertz) frequency band
- Smaller antennas – 1 to 2 meters in diameter
- Range commensurate with the missile system with which it is associated (10 to 80 nautical miles)
- Most are mounted on tracked or wheeled vehicles and are thus highly mobile
- Proficient operators will not emit radiation until an inbound aircraft is well within the lethal envelope of the missile.

Because target tracking radars must "tell" the missile where to fly so that an intercept is possible, these radars have beams that are quite narrow in both azimuth and elevation in order to precisely locate the targeted aircraft. Typical beam widths for target tracking radars are less than 1 degree in azimuth and in elevation. By comparison, early

warning radars typically have beam widths of more than 10 degrees in azimuth. While the target-tracking radar's narrow beam provides good tracking accuracy, it makes the job of acquiring a target difficult. Without an early warning radar to steer the tracking radar to the general location of the incoming aircraft, the target tracking radar would need to conduct a lengthy search (and the aircraft would most likely have enough time to fly by the threat without being engaged). The need for a narrow beam width dictates that these systems operate at higher frequencies than do early warning radars (higher frequency beams diverge less than do lower frequency beams). Surface-to-air missile commanders are aware of the various limitations associated with their equipment and employ different tactics to optimize their performance against hostile aircraft.

Over time, target tracking radars and the missile systems that they support have become increasingly mobile, enabling these systems to travel with the ground combat units that they typically defend. Because mobile systems are more difficult to locate and target than are fixed systems, mobility also serves a defensive function. The current emitter array at Fallon includes several SAM tracking radars that are not mobile (although these systems could presumably be disassembled, moved, and reassembled over a period of many hours) and several that are mounted on wheeled or tracked vehicles. Figure 10 shows one of the non-mobile simulator systems, and one of the mobile systems (a tracking radar for the Russian-built SA-6 SAM system, which carries both radars and missiles on tracked vehicles).

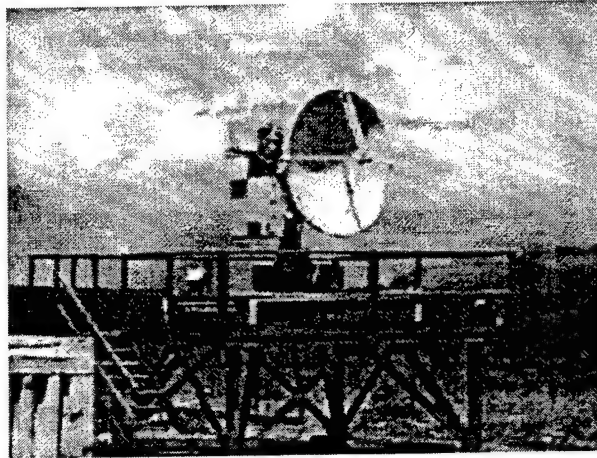


(U.S. Navy Photos)

**Figure 10. Example Fixed and Mobile SAM Site Target Tracking Radar:
U.S. Built Simulator and Russian Straight Flush Radar**

Air defense gun systems differ from SAM systems in that they fire a stream of projectiles (i.e., bullets) at their aircraft targets rather than missiles. Because gun

projectiles have shorter reach than missiles, target-tracking radars for gun systems tend to be short-range systems. Other than that difference, they function in the same way as do the target-tracking radars used with missile systems. In many cases, gun systems are integrated into the overall air defense system so that gun operators can be alerted when aircraft are detected and then provided with target tracks from early warning radars. Figure 11 shows one of the gun system target-tracking radars used at Fallon.



**Figure 11. Example Gun System Target Tracking Radar:
U.S. Built Simulator**

d. Radar Frequency and Range

As discussed previously, different types of radars operate at different frequencies (or equivalently, at different wavelengths) so as to better accomplish their intended functions. Figure 12 shows the operating frequencies for the emitter systems currently used at Fallon. No obvious gaps in simulating threat radar capabilities are evident from the frequency distribution for the existing emitter array.

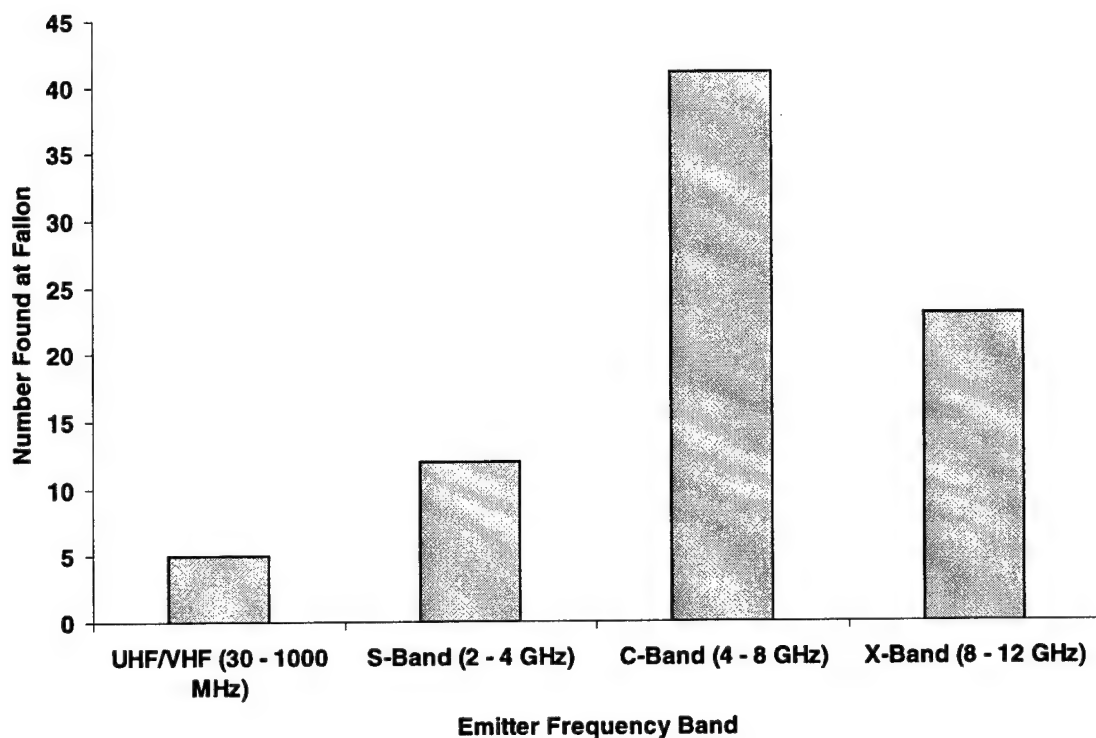


Figure 12. Frequency Distribution of Radars Currently in Place at Fallon

Figure 13 shows the nominal ranges of these radars. As the figure makes apparent, most of the current radars have only modest range (i.e., mostly below 200 nautical miles). This feature can be explained by the fact that most of the older surface-to-air missile systems represented at Fallon are relatively short-range systems. The target-tracking radars used with these missiles have ranges commensurate with the ranges of the missiles they were designed to support.

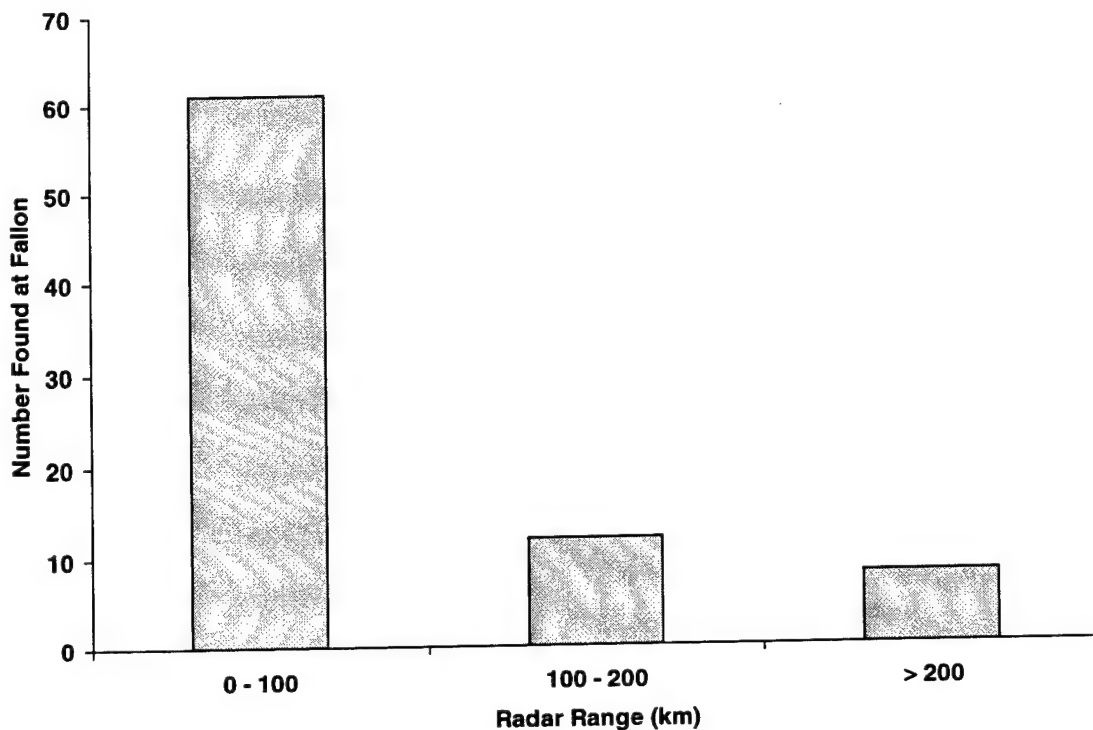


Figure 13. Range Distribution of Radars Currently Used at Fallon

e. Emission Control Doctrine

When and how long a radar is radiating at any given time is termed its emission control doctrine or EMCON. EMCON is important from the standpoint of the threat operator because aircraft are usually equipped with a radar-warning receiver that alerts the aircrew when the aircraft is illuminated by a radar. If a hostile radar is detected, the pilot may attempt to maneuver the aircraft outside the threat system's lethal envelope. Alternatively, the aircraft can launch a weapon [such as the High Speed Anti-Radiation Missile (HARM)] that is designed to home on the radiating radar and destroy it. Thus, few radar operators are willing to leave their systems on continuously.

Emission control doctrine is of interest here because it determines whether the presence of a radar site will change the frequency of aircraft flights over a given area. The EMCON procedures used by threat operators at Fallon change as the training becomes more complex. In the early phase of the training cycle, threat operators leave their radars on to give aircrews practice in identifying and avoiding threats. Thus, during this stage of training, fewer aircraft would fly over the site. As training progresses, threat operators employ increasingly advanced methods of radar utilization and emission control to simulate more sophisticated air defense threats. As a rule, these more

advanced practices would not be expected to affect the number of aircraft flying over a given air defense site.

f. Communications and Radar Jammers

A communications jammer is similar to a radar in that it has an antenna that receives and transmits electromagnetic energy. The communications jammer used at Fallon is designed to detect communications signals emitted by Navy aircraft and then to emit random noise at that frequency band so as to jam aircraft-to-aircraft communications. When being jammed, aircrews will hear more static in their radios and will probably spend more time trying to confirm orders from their flight lead. This additional stress is important for training aircrews because crystal clear communications are unlikely to be the norm. The operators of this jammer carefully tune the system's frequency to match the communications frequencies used by Navy aircraft. This step is essential because the jammer emits an omnidirectional beam to jam all aircraft in the area, unlike a radar which radiates only over a localized area. If the jammer were set to cover too broad a range of frequencies, it could affect commercial airliners, local radio stations, and cellular phones.

In addition, the Fallon range includes a radar jammer designed to counter the terrain-following radars that some U.S. military aircraft use to improve their capability to fly close to the ground and thereby avoid being detected by air defense radars. Terrain-following radars bounce radar signals off the ground and then detect the return signal. By measuring the time between the emission of the radar pulse and its subsequent detection, the radar can determine the altitude at which the aircraft is flying. When the radar is jammed, the pilot can no longer use it and must fly higher because he must now rely only on his vision to avoid terrain obstacles. However, when flying at higher altitude, the aircraft is more likely to be detected by ground-based radars. The radar jammers used at Fallon are designed to detect the signals from terrain-following radars and then radiate random noise in the appropriate frequency band. As is the case for the communications jammer described above, this jammer emits radiation in a narrow frequency band to avoid interfering with other systems.

g. Infrared-Guided Missile Threats

In addition to the various radar systems described above, the existing threat array at Fallon includes several sites occupied by man-portable infrared-guided (heat-seeking) missiles (see Figure 14). IR-guided missiles do not rely on radars to acquire their targets (although radar information can be used to alert the missile operator that aircraft have been detected and are flying at a specific altitude and in a specific direction). Instead, the operator must find the aircraft visually or with the aid of a camera or other electro-optical system. The missile then "locks onto" the heat emitted from the aircraft rather than to the returned radar signal. Despite their small size, IR-guided missiles can be quite lethal and have been proliferated worldwide owing to their relative ease of use and their low cost. Combat aircrews must always be on the lookout for IR-guided missile threats when flying at altitudes within the reach of these systems (about 20,000 feet above ground level). The IR-guided systems at Fallon enable Navy aircrews to practice identifying and avoiding this type of threat.

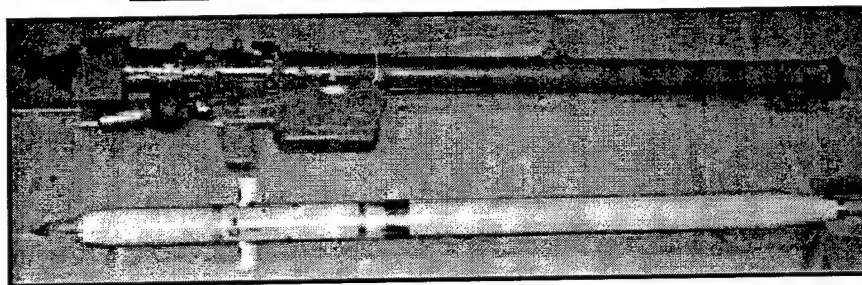


Figure 14. SA-16 IR-Guided Missile System

2. Limitations of Existing Emitters

The discussion above suggests several shortcomings in the existing emitter array at Fallon. The most important of these are the lack of advanced threat systems, the limited coverage provided by the existing array, and the limited mobility of the existing systems. As a result of these limitations, *the existing collection of threat radar systems at Fallon no longer provides a realistic training environment for the spectrum of potential adversaries that could confront naval aviators.*

a. Lack of Advanced Threats

All of the simulators and actual threat radars used at Fallon are representative of systems developed in the 1960s and 1970s. The capabilities of these older systems differ markedly from those of systems developed in the 1980s and 1990s and now used in many countries. The newer systems have longer range, can reach higher altitudes, have more complex guidance schemes, and are more resistant to countermeasures.

The latter characteristic is particularly important. Navy aircraft are typically equipped with a variety of electronic warfare systems designed to degrade the enemy's ability to locate, track, and target them. However, the manufacturers and users of air defense systems are aware of their vulnerability to deception and seek to develop technical and tactical solutions that reduce those vulnerabilities. Accordingly, electronic warfare techniques must continually evolve in order to counter the latest threats. The modern electronic-combat equipment carried on board today's aircraft can defeat many of the target tracking radars available at Fallon. For example, such techniques can fool the operator of one of the older systems into thinking that an aircraft is located at a different position or flying at a different speed than is actually the case. The newer, more advanced threats are capable of comparing the incoming velocity and range data with information stored in memory and determining that some combinations are infeasible and thus most likely the result of electronic deception.

Because knowing when and how to employ electronic combat techniques is an important part of combat aviation, aircrews must receive appropriate training. Consequently, training scenarios should include situations in which the adversary employs advanced techniques to counter the Navy's electronic combat systems. In short, if naval aviators are to be prepared to handle the new threats fielded since the 1980s, they must train against them. The existing threat array at Fallon does not provide this capability.

b. Limited Coverage

As discussed previously, target-tracking radars have ranges comparable to those of the missiles that the radars were designed to guide. Improvements in missile-guidance and propulsion technologies have made it possible for newer surface-to-air missiles to have longer range than did their predecessors. Consequently, the radars used with these newer missiles also have considerably longer range. Aircrews need to experience flying in defended airspace for time durations comparable to those expected in combat. The ability of aircrews to experience such stress is what separates actual flight training from simulators. Aircrews must learn that their decisions have real consequences and may affect not only their own survivability but also that of other aircraft in the formation. If a typical combat mission will traverse more than 100 nautical miles in enemy airspace, then the training range should try and duplicate this situation to the extent possible.

Figure 15 shows the distribution of distance in defended airspace that U.S. combat aircraft would have to fly to reach their targets, based on the average locations of defensive systems and targets in several potential conflict scenarios. When training at Fallon, aircraft flying typical attack profiles to reach targets in Dixie Valley will not be detected until the aircraft are relatively close. The surrounding mountains mask the incoming aircraft from the threat radars until the aircraft are almost over the valley, even though some of the radars have significantly greater range. This effect is evident in Figure 16, which provides an elevation profile as one moves west to east across the range. As the figure makes clear, an aircraft flying east to west at an altitude of 10,000 feet above sea level would not be detected by a radar located in Dixie Valley until the aircraft was only 25 to 30 miles away. The resulting level of threat coverage is representative of only about 10 percent of the targets in typical conflict scenarios. To duplicate the conditions experienced in attacking 50 percent of the expected targets, the training range should provide threats out to about 100 nautical miles.

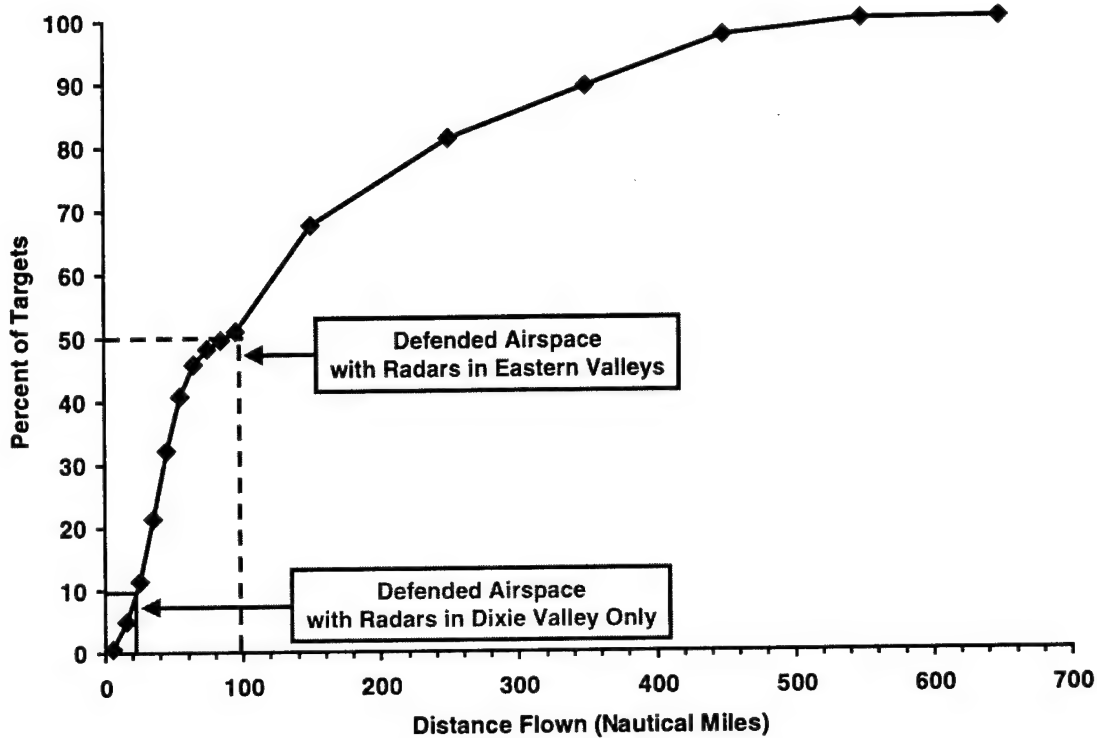


Figure 15. Distance Flown in Enemy Airspace Averaged Across Several Possible Conflict Scenarios

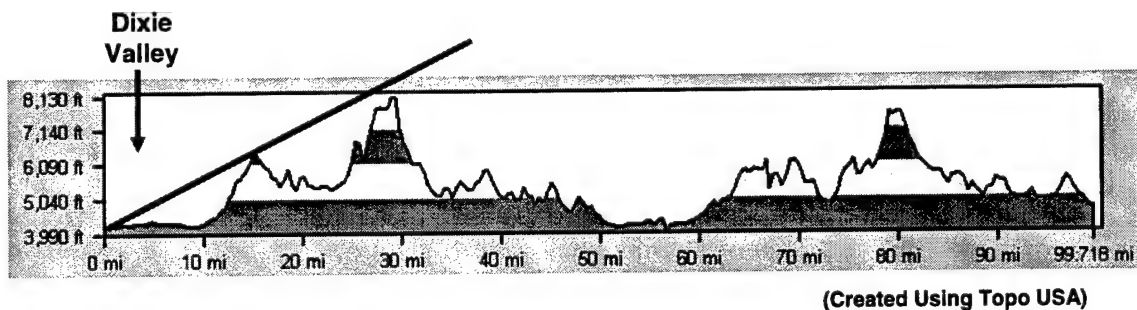


Figure 16. Elevation Profile from West to East Across Fallon Range Showing Line of Sight for Radars Located in Dixie Valley

c. Limited Mobility

Increased mobility is another important characteristic of newer threats that is not prevalent in the existing array at Fallon. Many of the air defense missile systems built in the 1960s and 1970s were designed to be employed from fixed sites. Such sites have

telltale signatures and can be located using any number of the intelligence-gathering systems available to the U.S. military. If the locations of the enemy's air defenses are known, Navy aircrews can choose routes to their targets that minimize the possibility of engagement. However, if the threats are mobile, it is likely that some will have moved between the time that intelligence collection occurs and the time that the aircraft conduct their missions. Consequently, some threats will be encountered in unexpected locations. Navy aircrews will have little time to decide how to maneuver, what tactics to use, and which electronic combat techniques to initiate. To accustom aircrews to making such important decisions rapidly, this stress must be duplicated on the training range. The current threat array at Fallon provides little opportunity for such training owing to the lack of mobile emitters combined with the inability to locate threats outside Dixie Valley.

E. UTILITY OF PROPOSED EMITTER SITES

The emitter array proposed in the Navy's plan includes 12 new Foreign Military Exploitation radar systems and 29 simulator radars. Some of these systems would be added to the existing array, others would be used as replacements for existing systems. According to the plan, emitters would be installed at seven additional staffed sites (one in Dixie Valley, one near the B-19 target complex, one near the B-20 target complex, and four in the eastern portion of the Fallon range). These new fixed sites would be supplemented with 15 to 18 mobile sites.

1. Characteristics and Advantages of Proposed Emitters

The Navy's plan calls for the acquisition of a wide variety of threat emitters over the next 10 years (see Table 3). The proposed threats include radar- and infrared-guided missile systems and an advanced air defense gun system. Among these threats are several of the most advanced Russian-built air defense systems as well as systems developed by China and several of our European allies. U.S. systems that have been exported are also included. Together, these systems accurately represent the range of capability available on the export market.

In general, the proposed threat systems have longer range than do the older systems now in use at Fallon (particularly the SA-10 and SA-12 SAM systems). The newer systems also tend to have superior electronic counter-countermeasure capabilities, and several are capable of engaging more than one target at the same time. This latter feature is important because such systems cannot be overwhelmed by having several flight groups approach from different directions. Yet another important characteristic of

the new systems is their increased mobility. The SA-10 missile launcher shown in Figure 17, for example, is mounted on a large truck that is capable of moving quickly and traveling at relatively high speed.

**Table 3. Advanced Radar Systems and Simulators
Proposed for Use at Fallon**

Name	Country of Origin	Guidance Mode	Fixed or Mobile	Range
SA-10	Russia	Radar	Mobile	Long
SA-12	Russia	Radar	Mobile	Long
SA-11	Russia	Radar	Mobile	Moderate
CSA-1	China	Radar	Mobile	Moderate
I-Hawk	USA	Radar	Mobile	Moderate
Crotale	France	Radar	Mobile	Short
SA-15	Russia	Radar	Mobile	Short
Roland	Germany / France	Radar	Mobile	Short
SA-13	Russia	Infrared	Mobile	Short
2S6 (Gun / SA-19)	Russia	Radar	Mobile	Very Short
RBS-70	Sweden	Infrared	Man-Portable	Very Short
Stinger	USA	Infrared	Man-Portable	Very Short



(Photos from *Jane's Land-Based Air Defense Systems*)

Figure 17. SA-10 Surface-to-Air Missile System

Of the existing tactical air defense systems available at Fallon, only one is truly mobile: the Russian-built SA-6 radar-guided SAM system. Many of the other systems, while not themselves mobile, can be made transportable by mounting them on appropriately sized trucks or trailers. Over the next several years, the Navy plans to augment these systems with the Russian-built SA-11 and SA-15. The SA-11 is a follow-on to the SA-6, while the SA-15 is a follow-on to the SA-8. Along with these Russian-built systems, the Navy plans to add several Western systems that have been exported widely: the U.S.-built I-HAWK, the German ROLAND, and the French Crotale. All of these systems were designed to move with the ground combat units that they protect, and hence are significantly more mobile than the existing radars at Fallon. Installing these threats on the Fallon range will enable Navy aircrews to train against the systems that now make up many nations' air defenses.

In addition to the radar-guided threats described above, the Navy plans to add to its existing collection of infrared-guided missile systems. To augment the existing SA-16 man-portable systems, the Navy will add two modern systems: the U.S. built Stinger and the Swedish RBS-70. The Navy also plans to acquire Russian-built SA-13 and 2S6 vehicle-mounted systems. The IR-guided SA-13 missile is carried on a tracked vehicle. The 2S6 combines a 30-mm air defense gun system with SA-18 IR-guided missiles. Since all of these systems have been widely proliferated (some by export, others by exploiting captured systems), their addition should enhance the quality of aviation training at the Fallon range.

2. Locations for Proposed Emitters

Placement of these systems involves a number of considerations. First, there is little to be gained by placing new radars in the locations occupied by existing emitters. The Navy's stated intention in acquiring these systems is to create a training environment that better represents the combat situations likely to confront naval aviators should conflict occur. As discussed previously, this means that aircrews must contend with threats for a considerable distance before reaching their targets. Installing longer-range radars in Dixie Valley will not increase the size of the defended airspace since the surrounding mountains mask the radars from incoming aircraft. Consequently, the new radars must be located east of Dixie Valley to increase the size of the defended airspace at the range. The Navy proposes to do this by placing sites in the Smith Creek, Edwards Creek, and Big Smokey Valleys. Figure 18 shows the effect of placing radars at these locations. An aircraft flying east to west across the range at an altitude of 10,000 feet would be within radar coverage for more than 150 miles before reaching the B-17 or B-20 target complexes.

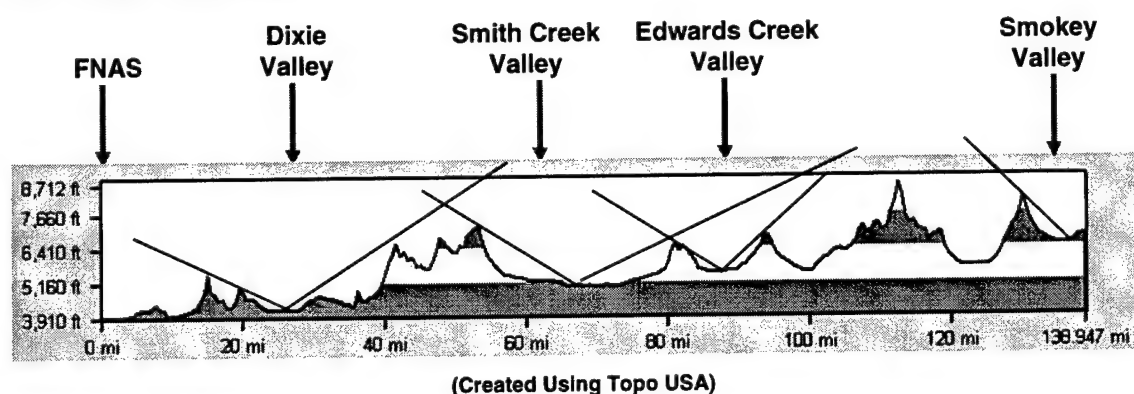


Figure 18. Elevation Profile from West to East Showing Line of Sight for Radars Located in Indicated Valleys

3. Employment of Proposed Emitters

According to the Navy plan, some emitters would be installed in a fixed site within each of the valleys,⁹ while other "mobile" systems would be operated from any of several pullouts off existing roads. The fixed sites would include one or more radar systems (most likely, one of the larger early warning, acquisition, or height finding

⁹ As part of the ongoing Environmental Impact Statement, the Navy is considering alternatives in which only mobile sites are used in two of the eastern valleys. Both fixed and mobile sites would be installed in the other two valleys.

systems) and one or more maintenance or storage buildings along with communications facilities. The fixed sites would typically occupy about 5 acres and would be fenced and inaccessible to the public. Whether the sites would be serviced by commercial electrical power has yet to be determined. In any case, these sites would have significant visual impact.

Although use of fixed sites restricts the number of training scenarios that can be developed and enables aircrews to memorize the locations of threat systems and adapt their flight profiles accordingly, the Navy claims that some fixed sites may be necessary. The limitations of the existing threat systems, the greater cost associated with mobile systems, and the need to establish reliable communications all argue against heavy reliance on mobile systems.

Many of the existing and proposed radars are large systems with very large antennas. Although some of these systems are mounted on trucks or tracked vehicles, it is unlikely that these vehicles could be used to move radar systems about the range. Many of the vehicles are inoperable and, since these are foreign systems, the necessary spare parts are not available. Even if the vehicles were in good condition, it is unlikely that the Navy could secure the appropriate permits to enable these vehicles to be operated on Federal or Nevada highways. Consequently, the Navy plans to load its "mobile" systems onto tractor-trailers and haul them about the range. The potential sites being considered for the mobile systems are all off existing roads that are sturdy enough to accommodate such loads. Once the system reaches the site, some time will be required to set up the microwave communications link to tie the site into the overall air defense network. Electrical power will be required to run the radars and any other ancillary equipment present at the site. Currently, no commercial power lines exist to any of the proposed sites. However, all of the equipment can probably be run using generators. To protect any equipment that is left at the site overnight, guards will be required, although system operators will be able to return to their homes. This general approach should enable Navy instructors to change scenarios on a day-to-day basis. Although many of these systems were designed for "shoot and scoot" tactics, it is unlikely that such rapid movement will be possible.

In addition to the above concerns, Navy personnel argue that cost considerations may require them to operate at least some systems from fixed sites. Several radars could be installed at a fixed site and supported by a single crew, whereas a separate crew would be needed for each mobile site. Mobile systems would also be burdened by the cost of transporting the system about the range; such costs would not be incurred by systems that

remain at fixed sites. Moreover, it is likely that mobile radars would require more frequent maintenance owing to their rougher treatment. Because the mobile systems would require storage and maintenance facilities similar to those used for fixed sites, the additional costs cited above would make mobile systems more expensive than fixed sites.

Finally, the need to establish reliable communications between each site and the central control facility at the Naval Air Station favors fixed sites. The Navy plans to link the sites using existing microwave communication facilities. Each site will need to establish line of sight between its antenna and an antenna on one of the existing microwave towers. (Because the towers are already heavily loaded, it is unlikely that additional antennas could be added to the towers.) Doing this from a fixed site should be easier than from a mobile site. In fact, the Navy proposes to link the mobile sites to nearby fixed sites rather than to the microwave towers directly. The fixed sites would then relay communications to and from the mobile sites.

F. ALTERNATIVE EMITTER LOCATIONS

Increased reliance on mobile targets and threat systems beyond that now planned by the Navy would enhance training realism and reduce impacts on public lands. Increased use of such systems would reflect the mobility of many important targets and increasing numbers of air defense systems. Aircrews need to become proficient at finding and attacking mobile systems (such as armored vehicles, ballistic missile launchers, and supply trucks) as well as in locating and countering the air defense systems that protect these units. Increased numbers of mobile systems would also enable Navy instructors to devise a wider variety of training scenarios. Sites could be positioned to duplicate the threat and target locations associated with specific nations. The locations of targets and threats could be changed frequently so that aircrews could not memorize their positions on the battlefield and devise "canned" solutions to avoid or otherwise defeat them. In short, greater use of mobile targets and threats would enable the Fallon training range to better reflect the uncertainties of the modern battlefield.

From the environmental perspective, increased use of mobile systems should impose less impact on public land. With mobile sites typically requiring turnouts off existing roads between one-eighth acre and one-third acre in size, much less land would be disturbed to prepare mobile sites than to develop fixed sites. Moreover, the sites could be accessible to the public when not being used by the Navy. Radars and communications systems could be operated on generator power so that no permanent structures would need to be installed. The systems could be housed at a centralized

maintenance and storage facility and moved onto the range only when needed (locating this facility in the eastern part of the range would reduce travel time). As a result, the sites would impose little or no visual impact when unoccupied.

In addition to increasing the number of mobile systems, distributing the emitter and target sites across a broader portion of the range would provide additional flexibility in establishing training scenarios. With a larger number of potential sites to choose from, scenario developers would be able to devise a wider range of training problems. The primary drawback to this scheme is the remote nature of many parts of the range, particularly the northeastern corner. Substantial travel time would be incurred in moving threat emitters and targets to such locations. If the decision is ultimately made to develop and use sites in remote parts of the range, the Navy should avoid improvements that open these areas to easy access.

Although the various factors mentioned in the preceding section are likely to limit the number of mobile sites that can be installed at the present time, the Navy should continue to pursue increased mobility for its threat and target systems. Many of the targets and threats that will be encountered in any future conflict will be mobile. And aircrews must become proficient in combating them. From the environmental perspective, use of mobile systems will have less impact on public land. Because the potential benefits of mobile systems seem considerable, the Environmental Impact Statement should carefully consider the tradeoffs between fixed and mobile sites.

G. PROPOSED MODIFICATIONS TO FALLON AIRSPACE AND TARGET COMPLEX

This section briefly describes the other changes that the Navy proposes to make to the airspace, target complex, and training land used at Fallon. As the ensuing discussion will show, *the proposed changes will enable more efficient use of the range and will improve the quality of training conducted there.* Adjustment of airspace boundaries will enable Navy aviators to employ several new weapon systems and should reduce bothersome noise to area residents. Changes to the target complexes will enable the Navy to spread training activities over a wider portion of the range. Expansion of withdrawn land around the existing target areas is a prudent safety measure and should provide additional protection from explosive hazards and should enable more realistic and higher quality training for Navy and Marine Corps ground forces that operate closely with Navy aircraft.

1. Airspace Modifications

The current airspace at Fallon comprises about 10,000 square miles. To improve the Navy's ability to control training activities, the airspace is divided into a number of sub-areas some that are closed to other aircraft and some that remain accessible. Included in the former are nine Restricted Areas, located over the existing target areas and the emitter sites in Dixie Valley. These regions are accessible only to military aircraft involved in training activities. The airspace also includes seven Military Operations Areas (MOAs), which are accessible for civil use. Navy aircraft are not allowed to release ordnance in these areas. On an as-needed basis the Navy requests the use of Air Traffic Control Assigned Airspace from the Federal Aviation Administration (FAA). Assigned airspace is a short-term, time-limited airspace reservation with specified lateral and altitude limits (usually between 18,000 and 28,000 feet). Altitude Reservations are another form of short-term, time-limited airspace reservations and are also approved by the FAA. Other airspace designations include Aerial Refueling Routes and Military Training Routes. These are corridors to, from, and through the Fallon airspace.

The Navy plans to extend the altitude limits above the B-17 and B-20 target areas from the current limit of 18,000 feet to 45,000 feet to enable use of new weapons now in development. The airspace around the B-16 target area will be realigned to reduce noise. Several other restricted areas and MOAs will be adjusted, most to reflect the realignment of airspace near B-16. These changes will improve the overall efficiency of the range and reduce bothersome noise from the B-16 range. The overall area occupied by the Fallon Range would essentially be unchanged by these modifications, however.

2. Training Land Modifications

As discussed previously, Navy-owned land at Fallon includes the B-16, B-17, B-19, and B-20 target areas and a portion of Dixie Valley where the existing array of threat systems is located. The remainder of Fallon training range consists of BLM-managed public land and private holdings. The Navy plan calls for further development of the existing Navy-owned land and an expansion of the amount of withdrawn land.

The Navy plans to construct three new fixed emitter sites on existing land: one at the north end of Dixie Valley, one near the B-19 target area, and one near the B-20 target area. Placing threat systems close to the B-19 and B-20 target areas will enable these targets to be used for more advanced training, thus reducing the burden on the heavily used B-17 target area. In addition, the Navy plans to increase its use of visual cueing

devices ("smokey SAMs," target image devices, and mobile targets) on existing land. Under the Navy plan, the number of air-ground training exercises conducted on Navy-owned land would increase. The proposed activities simulated combat search and rescue missions, small-scale special force operations that involve integrated interaction with aircraft, and close air support training. Ground forces will use blank ammunition and pyrotechnics such as smoke grenades. These training events would typically involve 6 to 15 personnel, 2 to 4 vehicles, and up to 2 helicopters.

The Navy plans to expand the amount of withdrawn land by an additional 127,000 acres (198 square miles). This land includes areas around the B-16, B-17, and B-19 target areas, near the Shoal Site next to the B-17 target area, and in Dixie Valley. These withdrawals would allow the Navy to close areas near the targets that contain off-range ordnance. In addition, the withdrawn land would provide space for 5 additional radar sites and up to 50 sites for actual and simulated targets, as well as additional space for integrated air-ground training.

3. Target Complex Modifications

The general characteristics of the four target areas at Fallon are as follows:

- B-16: This area includes two bull's eyes and is used primarily for basic and intermediate-level training in the delivery of conventional air-to-ground ordnance. No live ordnance is used in this target area, only practice and inert rounds can be employed.
- B-17: This area includes numerous three-quarter (3/4) scale mock targets, including an airfield, an industrial park, a petroleum tank farm, a missile assembly area, as well as a bull's eye, strafing target, and close air support (CAS) targets. Live ordnance can be employed in the eastern part of this target area.
- B-19: This area includes a bull's eye, strafing target, CAS and laser-designating areas, and tank targets. Live ordnance can be employed in this target area.
- B-20: This area includes two bull's eyes, a laser bull's eye, two strafing targets, and a mock submarine. Live ordnance can be employed in this target area.

Proposed changes to the target array include the following:

- B-16: No changes are proposed for this area.

- B-17: The Navy plans to add targets for heavy inert ordnance, a live mortar range for CAS, targets for helicopter ordnance, and laser-spot scoring to this target area. The changes will enable more realistic training.
- B-19: The Navy plans to add areas for integrated air-ground training to this target area. These areas would be used by such forces as SEAL teams, Navy Special Warfare teams, and forward air controllers involved in close air support operations.
- B-20: The Navy plans to construct a variety of mock targets in this target area in order to provide an alternative to the heavily used B-17 target area. The proposed targets include tactical units, an urban complex, a submarine facility, a tunnel, a SAM complex, an air field, a missile support area, a transformer station, and a radio relay facility.

H. PROPOSED MODIFICATIONS TO RANGE INSTRUMENTATION AND COMMUNICATION

In the near-term, proposed changes to the range instrumentation system will enable the Navy to record aircraft maneuvers at all altitudes throughout the range. Over the next several years, other changes to range instrumentation will enable more aircraft to be tracked and should eliminate more than half of the remote tracking stations now installed on the range. Proposed changes in range communication should enhance the Navy's ability to conduct aviation training at Fallon.

1. Range Instrumentation

The existing range instrumentation system used at Fallon is designated the Tactical Aircrew Combat Training System (TACTS). Aircraft positions are tracked using trilateration from ground antennas at 2 master sites and 30 remote sites. These sites enable the system to provide all-altitude coverage for the entire Fallon airspace, with the exception of the eastern portion of the range where aircraft must fly above 10,000 feet. The Navy proposes to modify the existing TACTS configuration by installing four additional sites in the eastern range to provide coverage for aircraft flying at low altitude. The installation of these sites would enhance the utility of TACTS by expanding the scope of flight activities recorded by the system.

Beginning in 2001, the Navy will install the Joint Tactical Combat Training System. This system relies on the satellite-based Global Positioning System (GPS) to track aircraft positions. Consequently, each aircraft needs to be in contact with only one

ground-based site in order to pass data to the master station. Because the TACTS sites have already been carefully located to optimize their coverage, the Navy plans to install the JTCTS receivers at some of these same sites. To provide sufficient space for the JTCTS receivers, the sites will need to be expended temporarily (from the current 256 square feet to 1,225 square feet). Once the entire system is installed and functioning properly, the Navy should be able to remove the TACTS equipment, at which point there will be 60 to 70 percent fewer remote instrumentation sites than is now the case. Under the current Navy plan, the Reno Military Operations Area (MOA) will not be outfitted with JTCTS. Because most of the aircraft operations in the Reno MOA are conducted at high altitude, the JTCTS tracking sites on the Fallon range should provide acceptable coverage for aircraft training in the Reno MOA.

2. Range Communications

Reliable communications are an essential component of all military operations, training included. The Fallon range employs a variety of communication systems to maintain contact with airborne aircraft, with the various weapon-scoring systems on the range, and with the various emitter sites in Dixie Valley. The latter connection is particularly important since it forms the backbone for integrating the different threat systems into the overall air defense network. These sites are connected to a control center at the Naval Air Station via fiber optic link. Several years ago a high-capacity datalink was installed between Fallon and Nellis Air Force Base to allow personnel at both ranges to monitor and control live missions, to control and display weapon and electronic warfare simulations, to engage in interactive teleconferencing, and to provide tactical communication among aircrews. This link has proven less effective than desired due to incompatibility between the range instrumentation systems used at Fallon and that used at Nellis. Once the Navy completes installation of the new JTCTS instrumentation, this incompatibility should be removed. Successful operation of this link should improve the quality of both ranges to conduct Joint Service training.

In the future, communications links will need to be installed to any new emitter sites on the eastern portion of the range so that these sites could also be included in the overall integrated air defense system. To the extent possible, the Navy plans to use existing microwave communications systems to accomplish this. However, additional equipment will need to be installed at each of the proposed emitter sites. The Navy also plans to install new voice communications equipment to support Reno MOA and to

replace an existing, but inadequate, communications switch at the Naval Air Station. These changes would enhance the Navy's ability to conduct aviation training at Fallon.

I. USE OF CHAFF, FLARES AND PYROTECHNICS

In addition to the various electronic systems described above, the Navy uses several other devices to improve the quality and realism of the training conducted on the Fallon range. Because these are often a concern to the public, they are discussed briefly here.

1. Chaff and Flares

Dispensing chaff or flares are two of the countermeasures available for use by aircrews to protect their aircraft from surface-to-air missiles. Chaff is a countermeasure device intended to deceive the radars that are used to acquire and track the aircraft or to guide anti-aircraft missiles. Chaff is initially dispensed as a small bundle consisting of about 5 million short aluminum-coated glass fibers. Shortly after being released from the aircraft, the chaff bundle separates so that the fibers can be spread by the wind. The resulting cloud can be tracked by radar and, when combined with appropriate maneuvers, can mask the aircraft's position. Flares, which are made of magnesium, are ignited upon being launched from the aircraft. They emit an intense infrared signal similar to that produced by the aircraft's engines. As such, the flare creates a false target that can seduce an inbound infrared-guided missile away from the aircraft. For either technique to be effective, the pilot must rapidly change the heading or speed of his aircraft shortly after dispensing chaff or flares. Because the timing of these maneuvers is critical, and because the degraded performance of the air defensive systems provides the only reliable indicator as to their effectiveness, aircrews must practice dispensing chaff and flares. Simulating the use of these devices does not provide effective training.

There is some concern that chaff fibers may pose a health hazard to humans or animals. Although there is no indication that this is the case, the General Accounting Office recently recommended that the Department of Defense review any open questions regarding the use of chaff and determine whether additional action is required [Ref. 22]. That review is now underway. As an additional step, the Navy is developing a new form of chaff that will break down more quickly than does existing chaff. The Navy plans to begin using this degradable chaff about mid-year 2000. Use of flares appears less controversial. Once the flare has burnt out, all that remains is a light ash of magnesium oxide.

2. Smokey SAMs

To accustom aircrews to the need to watch for air defense missiles that might be launched against their aircraft (especially difficult-to-detect infrared-guided missiles), the Navy uses pyrotechnic devices known as "Smokey SAMs." Smokey SAMs are about 2 feet long and 6 inches in diameter and emit a plume of smoke when ignited. The telltale smoke simulates a missile launch and cues nearby aircrews to take action to protect their aircraft by employing evasive maneuvers, engaging one of their electronic countermeasure systems, dispensing chaff or flares, or using some combination of these techniques. Use of these systems poses little hazard to the public, since the smokey SAMs are employed only on Navy-owned land. However, it may be advisable to install appropriate signs along nearby roadways to inform travelers that military training activities are being conducted in the area. The charred shells that remain after "Smokey SAMs" are used are retrieved after every training cycle.

3. Other Pyrotechnic Devices

Other pyrotechnic devices used on the Fallon range include smoke grenades and blank ammunition for small arms. Both types of devices increase the realism of the training conducted by ground units involved in integrated air-ground operations. Smoke grenades are most often used as a smoke source to designate a target for an aircraft, to indicate the wind direction for a landing helicopter, or to designate a helicopter-landing site. The friendly and aggressor forces that participate in these training activities often use blank ammunition. The sound of gunfire stimulates adrenaline flow and accustoms the trainees to the sounds of combat. Learning to make good decisions when working in a stressful environment is a significant part of military training.

Neither type of device should have a significant impact on the environment. Smoke plumes may be visible to the public, but should not be a cause for concern. Since only ground personnel use the grenades, an inadvertently set fire could be readily extinguished. Appropriately placed signs along the roadways could be used to alert the public. Other than noise, use of blank ammunition produces no appreciable effect. The expended cartridges are recovered after each training exercise.

Appendix A

GLOSSARY

Appendix A

GLOSSARY

AAA	anti-aircraft artillery
BLM	Bureau of Land Management
BRAC	Base Realignment and Closure
CAS	close air support
EIS	Environmental Impact Statement
EMCON	emission control (doctrine)
FAA	Federal Aviation Administration
FNAS	Fallon Naval Air Station
FRS	Fleet Replacement Squadron
FRTC	Fallon Range Training Complex
GPS	Global Positioning System
JTCTS	Joint Tactical Combat Training System
IADS	integrated air defense system
IR	infrared
MOA	military operations area
NEPA	National Environmental Policy Act
NSAWC	Naval Strike and Air Warfare Center

SAM	surface-to-air missile
SEAL	Sea-Air-Land
TACTS	Tactical Aircrew Combat Training System

Appendix B
REFERENCES

Appendix B

REFERENCES

1. *Fallon Range Training Complex Requirements Document*, Naval Strike and Air Warfare Center, 25 November 1998.
2. *Review of Proposed Requirements for the Navy Fallon Range Training Complex*, Task Order T-EK1-1720, IDA, 5 January 1999.
3. Discussions with BLM Personnel, Carson City, Nevada, 3 February 1999.
4. *Renewal of the Nellis Air Force Range Land Withdrawal*, Draft Legislative Environmental Impact Statement, Volumes I and II, Department of the Air Force, September 1998.
5. *Missions, Functions and Tasks of the Naval Strike and Air Warfare Center (NSAWC)*, OPNAV Instruction 5450.212C, Office of the Chief of Naval Operations, 10 March 1997.
6. "Fallon Becoming Navy's Air Combat 'Grad School'", *Aviation Week & Space Technology*, 8 March 1999.
7. "Top Gun Goal: Hone the Best", *Aviation Week & Space Technology*, 8 March 1999.
8. "Navy Needs 'Red-Air' Sorties", *Aviation Week & Space Technology*, 8 March 1999.
9. *NAS Fallon/Naval Strike and Air Warfare Center Range Requirements and Issues*, Briefing Presentation, CAPT R. Rogers, NAS Fallon, 2 February 1999.
10. Discussions with CAPT R. Rogers, Commanding Officer Fallon Naval Air Station, 2 February 1999.
11. Discussions with CAPT R. Rogers and Other Navy Personnel, Fallon Naval Air Station, 2-3 March 1999.
12. Private Correspondence, Mr. John Smith, Naval Strike and Air Warfare Center Range Department, 12 March 1999.
13. *Joint Tactical Combat Training System (JTCTS)*, Briefing Presentation and Discussion, Office of the Chief of Naval Operations (N889), 9 February 1999.
14. Discussion with CDR John Schwering, Office of the Chief of Naval Operations (N889), 9 February 1999.
15. *Enhanced Training in Idaho Environmental Impact Statement*, Department of the Air Force, January 1998.
16. Discussion with Col. Pease, Air Force Range and Airspace Division, 27 January 1999.

17. Discussion with Col. Wheelless, Air Combat Command, February 1999.
18. Discussions with Air Force Personnel, Nellis Air Force Base, 4 March 1999.
19. *Withdrawal of Public Lands for Range Safety and Training Purposes: Naval Air Station Fallon, Nevada*, Final Environmental Impact Statement, Volumes I and II, Department of the Navy, May 1998.
20. *Jane's Land-Based Air Defence*, Jane's Information Group Limited, Surrey, U.K., 1997.
21. *Jane's Radar and Electronic Warfare Systems*, Jane's Information Group Limited, Surrey, U.K., 1997.
22. *Environmental Protection: DOD Management Issues Related to Chaff*, GAO/NSIAD-98-219, United States General Accounting Office, September 1998.
23. *Renewal of the B-20 Land Withdrawal Naval Air Station Fallon, Nevada*, Final Legislative Environmental Impact Statement, Department of the Navy, December 1998.
24. *Central Nevada Communication Sites Proposed Plan Amendment and Environmental Assessment*, EA No – NV-030-96035, Carson City Field Office, Battle Mountain Field Office, Bureau of Land Management, March 1996.
25. *Central Nevada Communications Sites Modified Final Plan Amendment*, Carson City Field Office, Battle Mountain Field Office, Bureau of Land Management, 21 August 1998.

Appendix C

LIST OF FIGURES AND TABLES

Appendix C

LIST OF FIGURES AND TABLES

List of Figures

ES-1.	Fallon Range Training Complex	ES-3
1.	Extent and Types of Flight Operations at Fallon.....	6
2.	F/A-18 and F-14	8
3.	EA-6B and E-2C.....	9
4.	S-3B and HH-60	10
5.	Locations of Other Navy Training Ranges.....	15
6.	Air Force Ranges Located Within Unrefueled Flying Range of Fallon.....	16
7.	Radar Types Found in the Current Configuration at Fallon Training Range.....	19
8.	Example Early Warning Radar: Russian Flat Face	21
9.	Example Height Finding Radar: Russian Thin Skin	22
10.	Example Fixed and Mobile SAM Site Target Tracking Radar: U.S. Built Simulator and Russian Straight Flush Radar.....	23
11.	Example Gun System Target Tracking Radar: U.S. Built Simulator.....	24
12.	Frequency Distribution of Radars Currently in Place at Fallon	25
13.	Range Distribution of Radars Currently Used at Fallon	26
14.	SA-16 IR-Guided Missile System	28
15.	Distance Flown in Enemy Airspace Averaged Across Several Possible Conflict Scenarios	31
16.	Elevation Profile from West to East Across Fallon Range Showing Line of Sight for Radars Located in Dixie Valley	31
17.	SA-10 Surface-to-Air Missile System.....	34
18.	Elevation Profile from West to East Showing Line of Sight for Radars Located in Indicated Valleys.....	35

List of Tables

1. Flight Distance and Utilization for Air Force Bases	17
2. Current Threat Systems or Simulators Used at Fallon	18
3. Advanced Radar Systems and Simulators Proposed for Use at Fallon	33

Appendix D
DISTRIBUTION LIST

Appendix A

DISTRIBUTION LIST

Department of the Interior	No. of copies
Bureau of Land Management Carson City District Office 5665 Morgan Mill Road Carson City, NV 89701 ATTN: Ms. Terri Knutson	150
 Bureau of Land Management Nevada State Office P.O. Box 12000 Reno, NV 89520-0006 ATTN: Mr. Brian C. Amme	 20
 Department of the Navy	
Commander Fallon Naval Air Station Fallon, NV 89496 ATTN: CAPT David Rogers	5
 Naval Strike and Air Warfare Center Range Department (Code N8) 4755 Pasture Rd Fallon, NV 89496 ATTN: CDR John Stotz	 10
 Deputy Chief of Naval Operations (Resources, Warfare Requirements & Assessments) Air Warfare Division Aviation Manpower/Training Branch (N889F/K) 2000 Navy Pentagon Washington, DC 20350-2000 ATTN: CDR John Schwering	 1

Other Organizations**No. of copies**

Defense Technical Information Center
8725 John J. Kingman Road, STE0944
Fort Belvoir, VA 22060-6218

2

Institute for Defense Analyses
1801 N. Beauregard St.
Alexandria, VA 22311

19

Total Distribution

207

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
<small>Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.</small>				
1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE April 1999	3. REPORT TYPE AND DATES COVERED Final	
4. TITLE AND SUBTITLE Review of Navy Requirements for the Fallon Range Training Complex			5. FUNDING NUMBERS DASW01-98-C-0067 T-EK1-1720	
6. AUTHOR(S) L. Dean Simmons and Earl D. Potter				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Institute for Defense Analyses 1801 N. Beauregard Street Alexandria, VA 22311-1772			8. PERFORMING ORGANIZATION REPORT NUMBER IDA Paper P-3470	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Department of the Interior Bureau of Land Management Carson City District Office 5665 Morgan Hill Road Carson City, NV 89701			10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited.			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) <p>The Fallon Range Training Complex located near Fallon, Nevada, is the Navy's primary tactical combat aviation training facility for overland aircraft operations and the home of the Naval Strike and Air Warfare Center. The preponderance of air space used by the Navy (approximately 10,000 square miles) lies over public land managed by the Bureau of Land Management (BLM). Actual Navy holdings comprise approximately 100 square miles and include four target areas and land occupied by a collection of actual and simulated threat radar systems. The Navy recently proposed withdrawing additional public land and installing threat radars in the eastern portion of the Fallon range, where none are now located. As prescribed by the National Environmental Policy Act (NEPA), the Nevada State Office of BLM must prepare an Environmental Impact Statement that assesses the potential environmental impacts of the Navy plan and alternative courses of action. BLM asked IDA to review the Navy's Requirements Document for the Fallon Range Training Complex and provide information to assist BLM-Nevada in developing alternatives for analysis in the Environmental Impact Statement. This paper reports the results of that review.</p>				
14. SUBJECT TERMS Navy Aviation Training, Fallon Range Training Complex, Aviation Training Ranges			15. NUMBER OF PAGES 74	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT Same as report	